Lawrence Berkeley National Laboratory

Recent Work

Title

A TABULATION AND CLASSIFICATION OF THE STRUCTURES OF CLEAN SOLID SURFACES AND OF ADSORBED ATOMIC AND MOLECULAR MONOLAYERS AS DETERMINED FROM LOW ENERGY ELECTRON DIFFRACTION PATTERNS

Permalink

<https://escholarship.org/uc/item/4qh6b700>

Author

Ohtani, H.

Publication Date

1987-05-01

Lawrence Berkeley Laboratory

UNIVERSITY OF CALIFORNIA

Materials & Chemical Sciences Division

RECEIVED
LAWRENCE
BERKELEY LABORATORY

SEP 18 1987

LIBRARY AND
DOCUMENTS SECTION

Submitted to Progress in Surface Science

**A TABULATION AND CLASSIFICATION OF THE
STRUCTURES OF CLEAN SOLID SURFACES AND OF
ADSORBED ATOMIC AND MOLECULAR MONOLAYERS
AS DETERMINED FROM LOW ENERGY ELECTRON
DIFFRACTION PATTERNS**

H. Ohtani, C.-T. Kao, M.A. Van Hove,
and G.A. Somorjai

May 1987

TWO-WEEK LOAN COPY

*This is a Library Circulating Copy
which may be borrowed for two weeks.*

LBL-23106
c.2

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

A TABULATION AND CLASSIFICATION OF THE STRUCTURES OF CLEAN
SOLID SURFACES AND OF ADSORBED ATOMIC AND MOLECULAR MONOLAYERS
AS DETERMINED FROM LOW ENERGY ELECTRON DIFFRACTION PATTERNS

H. Ohtani, C.-T. Kao, M.A. Van Hove and G.A. Somorjai

Materials and Chemical Sciences Division,
Lawrence Berkeley Laboratory and Department of Chemistry,
University of California, Berkeley, California 94720

Abstract

A tabulation is presented of the ordering characteristics of clean and adsorbate-covered single crystal surfaces based on diffraction patterns observed with LEED (Low Energy Electron Diffraction). Over 3000 structures are classified by rotational symmetry of the substrate surfaces, and by important sub-classes which reflect recent directions of LEED studies. These include metallic monolayers, alloy surfaces, organic overlayers, coadsorbed overlayers, physisorbed overlayers, and high-Miller-index (stepped) surfaces. We review the important characteristics of each sub-class, and propose future directions of LEED investigations.

Contents

Abstract	1
Abbreviations	2
1. Introduction	2
2. The LEED Experiment	4
3. Interpretation of the LEED Pattern and Notation for Surface Structures	5
A. General Case	5
B. High-Miller-Index (Stepped) Surfaces	10
4. Review of Surface Structures Studied with LEED	15
A. Ordering Principles	15
B. Surface Restructuring	17
C. Simple Structures	19
D. Metallic Monolayers on Metal Surfaces	19
E. Alloy Surfaces	20
F. Organic Overlayers	21
G. Coadsorbed Overlayers	21
H. Physisorbed Overlayers	22
I. High-Miller-Index (Stepped) Surfaces	23
5. Future Directions	23
Acknowledgements	24
References	24
Table I. Surface Structures on Substrates with One-fold Rotational Symmetry	27
Table II. Surface Structures on Substrates with Two-fold Rotational Symmetry	29

Table III. Surface Structures on Substrates with Three-fold Rotational Symmetry	45
Table IV. Surface Structures on Substrates with Four-fold Rotational Symmetry	64
Table V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces	85
Table VI. Surface Structures of Alloys	99
Table VII. Surface Structures Formed by Adsorption of Organic Molecules	101
Table VIII. Coadsorbed Overlayer Structures	111
Table IX. Physisorbed Overlayer Structures	115
Table X. Surface Structures on High-Miller-Index (Stepped) Substrates	117
References for Tables I-X	125

Abbreviations

AES	Auger Electron Spectroscopy
HEIS	High Energy Ion Scattering
HREELS	High Resolution Electron Energy Loss Spectroscopy
LEED	Low Energy Electron Diffraction
MEIS	Medium Energy Ion Scattering
SEXAFS	Surface Extended X-Ray Absorption Fine Structure
STM	Scanning Tunneling Microscopy
TDS	Thermal Desorption Spectroscopy
UPS	Ultraviolet Photoelectron Spectroscopy
XPS	X-Ray Photoelectron Spectroscopy

1. Introduction

During the last twenty-five years low energy electron diffraction (LEED) has provided the lion's share of information on the structure of clean single-crystal surfaces and of ordered atomic or molecular adsorbates on these surfaces. In most experiments the size and the orientation of the surface unit cell was determined under well-defined conditions of temperature and exposure to ambient gases to be adsorbed. The surfaces are first cleaned in ultra high vacuum by ion sputtering or by chemical means, the composition being monitored by electron or ion spectroscopies, then the surface structure is studied by LEED. Although methods of surface structure determination have been developed to obtain interatomic distances and angles, only the size and orientation of the surface unit cell is reported in most investigations. The reason for this is that the aim of the investigations has been the study of chemical or electronic properties of surfaces with less emphasis on the detailed atomic surface structure.

Reports of two-dimensional surface structures have rapidly accumulated in recent years. Somorjai and Szalkowski¹ listed over 200 surface structures in 1971 and extracted certain rules of ordering. In 1979 Castner and Somorjai² reported over 1000 surface structures. In addition, Bibérian and Somorjai³ reviewed the surface structures of metallic monolayers on metal crystal surfaces; these represented a rapidly growing sub-class of monolayer structures.

This review updates and expands the surface structural data obtained for both clean and adsorbate-covered surfaces of single crystals: over 3000 surface structures are tabulated, most of which were studied in the last several years. These include clean and adsorbate-covered structures of single-crystal surfaces with high Miller indices and of polyatomic solids, as well as many simpler surface structures.

The available data indicate the predominance of ordering of clean solid surfaces and of adsorbed monolayers; however, these ordered surfaces only exist within a given range of temperature and coverage. It seems that there are always temperature and coverage ranges where ordered surfaces exist. There are many reconstructed surfaces and adsorbed monolayers which form both commensurate and incommensurate surface structures. A commensurate surface structure has a superlattice periodicity which is simply related to the substrate lattice periodicity, whereas an incommensurate surface structure has a superlattice periodicity independent of the substrate lattice periodicity. More accurate definitions of these terms and their physical implications will be given in Section 3.A and in Section 4.A, respectively.

Interesting trends of research can be identified from the data that have been reported in recent years. There is increased interest in investigations of alloy surfaces and of high Miller index (stepped) surfaces of metals. The studies of metal monolayers and organic overlayers are very rapidly growing directions of research. A large number of studies have focussed on inert gas adsorption and ordering, on the chemisorption of halogen atoms, especially chlorine, and on the coadsorption and ordering of two different adsorbates. On the other hand, there is a scarcity of surface structural information on polyatomic solids (oxides, sulfides, silicates carbonates, etc.). Also many important monatomic solids were not investigated by LEED, including boron, uranium, and manganese.

Reflecting these trends of LEED investigations, we have organized and classified the surface structural data in the following way. All the surface structures, except those formed by adsorption of organic molecules, are classified according to the rotational symmetry of the substrate surfaces when clean and unreconstructed; the surface structures formed on substrates with one-fold, two-fold, three-fold, and four-fold rotational symmetry are tabulated in Table I, II, III, and IV, respectively. The rotational symmetry of alloy surfaces is assumed to be the same as for the pure metal surfaces of the main component. This classification permits useful correlation of the various surface structures.

In addition, important subsets of the surface structures have been extracted and have been gathered in Tables V-X in order to clarify the characteristic trends in these areas. The surface structures of metallic monolayers on metal crystal surfaces and the alloy surface structures are collected in Tables V and VI, respectively. We highlight the surface structures formed by adsorption of organic molecules in Table VII. Similarly, coadsorbed overlayer structures and physisorbed overlayer structures are listed in Tables VIII and IX, respectively. The surface structures of high-Miller-index or stepped surfaces are listed in Table X. The trends and highlights in each sub-class are discussed in Section 4.

In recent years surface crystallography by LEED has successfully determined the precise location of the atoms within the surface unit cell (3 dimensional LEED), and the bond lengths and orientations of ordered adsorbed molecules have been also determined by this method.⁴ A disordered monolayer structure has also been solved by LEED crystallography recently.⁵ The surface structures that have been solved by LEED surface crystallography are marked with an asterisk "*" in the surface structure tables. The surface structures that were solved by surface science techniques other than LEED are marked with an exclamation sign "!" in

the tables. These techniques include surface extended x-ray absorption fine structure (SEXAFS), medium energy ion scattering (MEIS) and high energy ion scattering (HEIS), etc.

2. The LEED Experiment

A schematical LEED experiment is shown in Fig. 1. A monoenergetic beam of electrons (10 eV to 300 eV) is directed at the surface of a single crystal which backscatters a portion of the incoming electrons. A set of hemispherical grids is used to remove the inelastically backscattered electrons while the elastically backscattered electrons are post-accelerated onto a phosphorous screen for viewing of the diffraction pattern. The crystal and the detection system are enclosed in a ultrahigh vacuum (UHV) chamber in order to attain and maintain a clean surface. The diffraction pattern on the phosphorous screen can be viewed and photographed from outside the UHV chamber. A polaroid camera is commonly used for photographing the diffraction pattern and the published LEED patterns are from such photographs.

LEED is commonly combined with other techniques such as Auger electron spectroscopy (AES), ultra-violet photoelectron spectroscopy (UPS), X-ray photoelectron spectroscopy (XPS), high resolution electron

Fig. 1. Schematic of a low energy electron diffraction apparatus employing the post-acceleration technique.

XBB 708-3583

energy loss spectroscopy (HREELS), and thermal desorption spectroscopy (TDS). This allows correlation of the surface structural information with other useful information on surfaces such as chemical composition, electronic properties, vibrational properties, and adsorption energetics.

A well ordered crystal surface will yield a diffraction pattern consisting of bright, well defined spots with very low background intensity. The sharpness and overall intensity of the spots depend on the degree of order of the surface. Although the surface may be somewhat irregular on the scale of a micron or more, the presence of sharp diffraction features indicates that the surface is ordered on an atomic scale, i.e., most of the surface atoms are located in a two-dimensional lattice structure.

The electron beam source commonly used yields an instrumental response width of about 100Å. This means that sharp diffraction features are obtained only if the regions of well-ordered atoms ("domains") have an area of (100Å)² or larger. Diffractions from smaller domains give rise to beam broadening.⁶ Any random defects in the periodic array of atoms (including point defects and steps) gives rise to "diffuse intensity" in all directions.

Other types of LEED apparatus have also been developed, such as rear-view LEED⁷ and low current electron-counting LEED⁸ (or also called digital LEED). In the former case, phosphor is coated onto a transparent electrode substrate so that one can observe the diffraction pattern from the rear side of the LEED screen. This method is useful especially with bulky sample manipulators which otherwise would block a large part of the diffraction image. By using rear-view LEED, one can readily employ, for example, precision manipulators with azimuthal rotation or tilt capabilities, with heating and cooling capabilities, or with high pressure cell around the crystals.

Digital LEED shares these advantages with rear-view LEED. Digital LEED eliminates the phosphor screen, and instead directly measures the current due to the back scattered electrons from the sample using a position-sensitive detector. Because of the low beam current ($\sim 10^{-12}$ Amps) required for this technique, one can examine electron beam sensitive materials. Also, the high instrumental signal to noise ratio allows one to analyze diffuse LEED patterns due to the disordered surface structures.

3. Interpretation of the LEED Pattern and Notation for Surface Structures

A. General Case

LEED spot patterns represent the reciprocal lattice of the surface. The diffraction pattern must be inverted to real space in order to obtain the real-space periodicity. In this section we describe how this conversion is performed. First, the relationship between the reciprocal and real-space lattices of the substrate will be given. Then the determination of the surface periodicity from the LEED patterns will be discussed.

The pattern of spots has two-dimensional translational periodicity which is given by the vector $\vec{T}^*$, which has the form

$$\vec{T}^* = m^* \vec{a}^* + n^* \vec{b}^* \quad (3.1)$$

where m^* and n^* are integers and $\vec{a}^*$ and $\vec{b}^*$ are the basis vectors of the reciprocal unit cell. The reciprocal lattice, T^* , is related to the real-space lattice, $\vec{T}$,

$$\vec{T} = m \vec{a} + n \vec{b} \quad (3.2)$$

where m and n are integers and $\vec{a}$ and $\vec{b}$ are the basis vectors of the primitive surface lattice. The reciprocal unit cell vectors $\vec{a}^*$ and $\vec{b}^*$ are related to the real-space unit-cell vectors $\vec{a}$ and $\vec{b}$ by the following equations:

$$\vec{a}^* = \frac{\vec{b} \times \vec{z}}{\vec{a} \cdot (\vec{b} \times \vec{z})} \quad (3.3a)$$

$$\vec{b}^* = \frac{\vec{z} \times \vec{a}}{\vec{a} \cdot (\vec{b} \times \vec{z})} \quad (3.3b)$$

where $\vec{z}$ is normal to the surface. The relationship between the reciprocal and real-space vectors for a two-dimensional hexagonal lattice is shown in Fig. 2.

Reconstruction of the clean surface or adsorption of a gas on a surface usually results in a change in the diffraction pattern corresponding to the appearance of a new surface periodicity; the new lattice is called a superlattice. This is illustrated in Fig. 3, which shows a diffraction pattern of a clean Pt(111) surface and the diffraction pattern formed after the adsorption of an ordered layer of acetylene. Figure 4 shows the unit cells responsible for the diffraction patterns in Fig. 3 superimposed on a model of the Pt(111) surface. No information concerning the location of the adsorbate species within this unit cell (the location relative to the substrate atom positions) is indicated. This information can be obtained only from analysis of the diffraction spot intensities.

To make the transition from the diffraction pattern in Fig. 3 to the surface structure in Fig. 4, we need to reference the reciprocal superlattice to the reciprocal substrate lattice defined by the vectors $\vec{a}^*$ and $\vec{b}^*$. This

XBL 787-9590

Fig. 2. Real-space basis vectors $\vec{a}$ and $\vec{b}$ and reciprocal-space basis vectors $\vec{a}^*$ and $\vec{b}^*$ of a two-dimensional hexagonal lattice.

Fig. 3. LEED patterns of a clean Pt(111) (left) surface and the same surface with an ordered overlayer of acetylene (right). For both diffraction patterns, the incident beam energy is 68 eV. A spot of the center of the pattern and several other spots on the right in the patterns are invisible due to obstruction by the sample manipulator.

XBB 750-8226

XBL 7510-7551

Fig. 4. Real-space unit cells of Pt(111)-(1 $\times$ 1) and Pt(111)-(2 $\times$ 2)-C₂H₂ surface structures.

is carried out by a visual inspection of the diffraction pattern, in which the differences in spot intensities are neglected and only the positions of the diffraction beams are considered.

For the general case, the relationship of reciprocal substrate lattice to the reciprocal superlattice is given by the equations

$$\vec{a}^* = m_{11}^* \vec{a}^{*'} + m_{12}^* \vec{b}^{*'} \quad (3.4a)$$

$$\vec{b}^* = m_{12}^* \vec{a}^{*'} + m_{22}^* \vec{b}^{*'} \quad (3.4b)$$

where $\vec{a}^{*'}$ and $\vec{b}^{*'}$ are the basis vectors of the reciprocal superlattice and the coefficients m_{11}^* , m_{12}^* , m_{21}^* , and m_{22}^* define the matrix

$$M^* = \begin{pmatrix} m_{11}^* & m_{12}^* \\ m_{21}^* & m_{22}^* \end{pmatrix} \quad (3.5)$$

In real space the superlattice is related to the substrate lattice by the equations

$$\vec{a}' = m_{11} \vec{a} + m_{12} \vec{b} \quad (3.6a)$$

$$\vec{b}' = m_{21} \vec{a} + m_{22} \vec{b} \quad (3.6b)$$

where $\vec{a}'$ and $\vec{b}'$ are the basis vectors of the primitive superlattice and the coefficients m_{11} , m_{12} , m_{21} , and m_{22} define the matrix

$$M = \begin{pmatrix} m_{11} & m_{12} \\ m_{21} & m_{22} \end{pmatrix} \quad (3.7)$$

The coefficients of the two matrices M and M^* are related by the following equations:

$$m_{11} = m_{11}^* \quad (3.8a)$$

$$m_{12} = m_{21}^* \quad (3.8b)$$

$$m_{21} = m_{12}^* \quad (3.8c)$$

$$m_{22} = m_{22}^* \quad (3.8d)$$

so that if either M or M^* is known, the other may be very easily obtained. In LEED experiments, M^* is determined by visual inspection of the diffraction pattern and then transformed to give M , which defines the surface structure in real space.

For the case of ordered adsorption on Pt(111), visual inspection of the LEED patterns in Fig. 3 gives

$$M^* = \begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}$$

The matrix M thus becomes

$$\begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}$$

so that $\vec{a}' = 2\vec{a}$ and $\vec{b}' = 2\vec{b}$, as depicted in Fig. 4.

A superlattice is termed commensurate when all matrix elements M_{ij} ($i, j = 1, 2$) are integers. If at least one matrix element M_{ij} is an irrational number, then the superstructure is termed incommensurate. Superlattices can be incommensurate in one surface dimension or in both surface dimensions.

Alternatively to the matrix method of denoting surface structures, another system, originally proposed by Wood, is more commonly used. Whereas the matrix notation can be applied to any system, Wood's notation can only be used when the angle between the superlattice vectors $\vec{a}'$ and $\vec{b}'$ is equal to the angle between the substrate vectors $\vec{a}$ and $\vec{b}$. If this condition is met, the surface structure is labeled using the general form

$$p(u \times v)R\Phi^\circ \text{ or } c(u \times v)R\Phi^\circ, \quad (3.9)$$

depending on whether the unit cell is primitive or centered (the prefix p is often dropped). In Wood's notation the adsorbate unit cell is related to the substrate unit mesh by the scale factors u and v , where

$$|\vec{a}'| = u|\vec{a}|, \quad (3.10a)$$

$$|\vec{b}'| = v|\vec{b}|. \quad (3.10b)$$

The label $R\Phi^\circ$ indicates a rotation of the superlattice by Φ° from the substrate lattice. For $\Phi = 0$, the $R\Phi^\circ$ label is omitted, so the surface structure in Fig. 4 is labeled as $p(2 \times 2)$ or simply (2×2) . The label for the total system refers to the type of substrate, the superlattice periodicity, and the surface species. The platinum-acetylene adsorbate system shown in Fig. 4 would be labeled $\text{Pt}(111) - \begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix} - \text{C}_2\text{H}_2$ in matrix notation and as $\text{Pt}(111) - p(2 \times 2) - \text{C}_2\text{H}_2$ in Wood's notation. Wood's notation is more commonly used, and the matrix notation is usually applied only to systems to which Wood's notation does not apply, namely for which the angle between the superlattice vectors differs from the angle between substrate vectors.

An example of an adsorbate that produces a centered unit cell is shown in Figs. 5 and 6. In Fig. 5 diffraction patterns are shown from a clean $\text{Rh}(100)$ surface and from a $\text{Rh}(100)$ surface after exposure to one half monolayer of oxygen. By visual inspection it can be seen that

$$M^* = \begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$$

Fig. 5. LEED patterns of (a) clean $\text{Rh}(100)$ at 74 eV, and (b) oxygen-covered $\text{Rh}(100)$ at 85 eV.
XBB 780-13148

XBL 787-9589

Fig. 6. Real-space unit cells for the two notations $(\sqrt{2} \times \sqrt{2})R45^\circ$ (solid lines) and $c(2 \times 2)$ (dashed lines) for an oxygen structure on the Rh(100) surface.

so Eqs. (3.8a-d) yield

$$M = \begin{pmatrix} 1 & 1 \\ -1 & 1 \end{pmatrix}$$

M defines the primitive unit cell of the adsorbate, which is drawn with solid lines in Fig. 6. This unit cell is labeled $(\sqrt{2} \times \sqrt{2})R45^\circ$ in Wood's notation. Since the centered unit cell drawn in with dotted lines in Fig. 6 also describes the adsorbate unit cell, another way of labeling this structure would be $c(2 \times 2)$. The total system is labeled as $\text{Rh}(100) - \begin{pmatrix} 1 & 1 \\ -1 & 1 \end{pmatrix} - \text{O}$, $\text{Rh}(100) - (\sqrt{2} \times \sqrt{2})R45^\circ - \text{O}$, or $\text{Rh}(100) - c(2 \times 2) - \text{O}$.

Unreconstructed surfaces of some common face-centered cubic (fcc), body-centered cubic (bcc), and hexagonal close-packed (hcp) crystal structures are shown in Fig. 7. The unreconstructed surface has a surface unit cell that is predicted by the projection of the bulk X-ray unit cell onto that surface. That unit cell is denoted as $p(1 \times 1)$ or (1×1) by Wood's notation. The same surface unit lattice is denoted by $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ in the more general matrix notation. In Table 1 several superlattices that are commonly detected on low-Miller-index surfaces are listed both by their matrix and by their Wood notations.

B. High-Miller-Index (Stepped) Surfaces

The atomic structures of high-Miller-index surfaces are composed of terraces, separated by steps, which may have kinks in them. For example, the $(7\bar{7}5)$ surface of an fcc crystal consists of (111) terraces, six atoms wide, separated by steps of $(1\bar{1}1)$ orientation and single-atom height.

Fig. 7. Atomic arrangement in various unreconstructed, unrelaxed clean metal surfaces. In each panel, the top and bottom sketches give top and side views, respectively.

bcc (110)

bcc (100)

XBL 874-1672

bcc (111)

hcp (0001)

XBL 874-1673A

Fig. 7. Continued.

Table 1. Wood and matrix notations for a variety of superlattices on low-Miller-index crystal surfaces.

Substrate	Superlattice unit cell	
	Wood notation	Matrix notation
fcc(100), bcc(100)	p(1×1)	$\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$
	c(2×2) = ($\sqrt{2} \times \sqrt{2}$)R45°	$\begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$
	p(2×1)	$\begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$
	p(1×2)	$\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}$
	p(2×2)	$\begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}$
	(2 $\sqrt{2} \times \sqrt{2}$)R45°	$\begin{pmatrix} 2 & 2 \\ -1 & 1 \end{pmatrix}$
fcc(111) (60° between basis vectors)	p(2×1)	$\begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$
	p(2×2)	$\begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}$
	($\sqrt{3} \times \sqrt{3}$)R30°	$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$
fcc(110)	p(2×1)	$\begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$
	p(3×1)	$\begin{pmatrix} 3 & 0 \\ 0 & 1 \end{pmatrix}$
	c(2×2)	$\begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$
bcc(110)	p(2×1)	$\begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$

The step notation devised by Lang and Somorjai⁹ compacts this type of information into the general form

$$w(h_1k_1l_1) \times (h_2k_2l_2) \quad (3.11)$$

where $(h_1k_1l_1)$ and $(h_2k_2l_2)$ are the Miller indices of the terrace plane and the step plane, respectively, while w is the number of atoms that are counted in the width of the terrace, including the step-edge atom and the in-step atom. Thus, the fcc(775) surface is denoted by $7(111) \times (11\bar{1})$, or also by $7(111) \times (111)$ for simplicity. A stepped surface which has steps that are themselves high-Miller-index faces is termed a kinked surface. For example, the fcc(10,8,7) = $7(111) \times (310)$ surface is a kinked surface. The step notation is, of course, equally applicable to surfaces of bcc, hcp, and other crystals, in addition to surfaces of fcc crystals. However, the overwhelming majority of experimental research on high-Miller-index surfaces has utilized fcc crystals.

There is another notation called "microfacet notation" developed by Van Hove and Somorjai.¹⁰ This notation is based on the idea that any Miller-index-vector (hkl) which specifies a certain crystal face can be decomposed in terms of three linearly independent vectors such as (111), (110), and (100). For example the fcc(10,8,7) kinked surface has the microfacet notation, fcc[7₁₄(111)+1₁(110)+2₂(100)]. By using this notation, we can easily recognize that the (10,8,7) unit cell contains fourteen unit cells of the (111) microfacet, one unit cell of the (110) microfacet, and two unit cells of the (100) microfacet.

The surface structures observed on stepped surfaces are listed in Table X. Here the crystal faces are denoted either by their Miller indices or by their stepped surface notation, depending on which system was used by the original authors. Table 2 describes the correlation between these two notations for fcc crystals. Using this table, one may convert back and forth between the two notations.

Table 2. Correspondence between the Miller-Index Notation and Stepped Surface Notation

Miller Index	Stepped Surface Designation	Angle Between the Macroscopic Surface and Terrace (degrees)
(544)	(S)-[9(111)×(100)]	6.2
(755)	(S)-[6(111)×(100)]	9.5
(533)	(S)-[4(111)×(100)]	14.4
(211)	(S)-[3(111)×(100)]	19.5
(311)	(S)-[2(111)×(100)]	29.5
	(S)-[2(100)×(111)]	25.2
(511)	(S)-[3(100)×(111)]	15.8
(711)	(S)-[4(100)×(111)]	11.4
(665)	(S)-[12(111)×(111)]	4.8
(997)	(S)-[9(111)×(111)]	6.5
(332)	(S)-[6(111)×(111)]	10.0
(221)	(S)-[4(111)×(111)]	15.8
(331)	(S)-[3(111)×(111)]	22.0
	(S)-[2(110)×(111)]	13.3
(771)	(S)-[4(110)×(111)]	5.8
(610)	(S)-[6(100)×(110)]	9.5
(410)	(S)-[4(100)×(110)]	14.0
(310)	(S)-[3(100)×(110)]	18.4
(210)	(S)-[2(100)×(110)]	26.6
	(S)-[2(110)×(100)]	18.4
(430)	(S)-[4(110)×(100)]	8.1
(10,8,7)	(S)-[7(111)×(310)]	8.5

4. Review of Surface Structures Studied with LEED

Tables I-X list over 3,000 surface structures, most of which have been reported within the past several years. The low-Miller-index metal surfaces and atomic adsorbates were studied predominantly in earlier years. In recent years more emphasis has been put on the polyatomic solids (compounds, alloys) surfaces, high-Miller-index stepped surfaces and the molecular overlayers with increasing complexity.

We shall in this section discuss some of the important trends that can be extracted from the surface structure tables.

A. Ordering Principles

As our Tables I-X show, a large number of ordered surface structures can be produced experimentally. Ordering can manifest itself both as commensurate and as incommensurate structures. There are also many disordered surfaces, which often are not reported in the literature. The disordered structures are usually difficult to describe accurately and are therefore difficult to reproduce exactly in other laboratories. Nevertheless, for selected surfaces, order-order and order-disorder phase transitions have been explored in considerable detail both experimentally and theoretically.

In our tables, a number of disordered surface structures are listed. However, it should be stressed that many structures reported as having a (1×1) LEED pattern may well include small or large amounts of disorder, whether in the overlayer structure or even in the substrate structure.

(i) Adsorbate-adsorbate and adsorbate-substrate interactions. The driving force for surface ordering originates, analogous to three-dimensional crystal formation, in the interactions between atoms, ions, or molecules in the surface region. The physical origin of the forces is of various types, and the spatial dependence of these interaction forces is complex.

For adsorbates, an important distinction must be made between adsorbate-substrate and adsorbate-adsorbate interactions. The dominant adsorbate-substrate interaction is due to strong covalent or ionic chemical forces between the adsorbates and the substrate in the case of chemisorption, or to weak Van der Waals forces in the case of physisorption. Adsorbate-adsorbate interactions could be covalent bonding interactions, orbital-overlapping interactions, electrostatic interactions (ex. dipole-dipole interactions), Van der Waals interactions, etc. These are many-body interactions that could be attractive or repulsive depending on the system.

In chemisorption it is usually the case that the adsorbate-adsorbate forces are weak compared to the adsorbate-substrate binding forces (except at very close repulsive range, since atoms will not overlap). Chemisorbed species with strong unbalanced adsorbate-adsorbate forces will not be stable, and will easily undergo rearrangement or surface chemical reaction to transform into a more stable state. The adsorbate-substrate interaction includes a corrugation parallel to the surface, favoring certain adsorption sites over others and implying barriers to diffusion. This imposes the constraint that only lattice sites be occupied. With weak adsorbate-adsorbate forces the locations of the adsorbed atoms or molecules are determined by the optimum adsorbate-substrate bonding. But the adsorbate-adsorbate interactions still manage to dominate the long-range ordering of the overlayer.

A compromise is found in the formation of an adsorbate lattice that is simply related to the substrate lattice. In the ordered case this yields commensurate superlattices. The most common of these are simple superlattices with one or two adsorbates per superlattice unit cell. They occur for adsorbate coverages of $1/4$, $1/3$, $1/2$, for example (we define the surface coverage to be unity when each (1×1) substrate cell is occupied by one adsorbate).

A special case of commensurate superlattice is the formation of periodic out-of-phase domains. They occur especially when the adsorbate coverage is not well matched to form a simple ordered lattice. Then equal domains of simple structure are mismatched to each other through dislocations (domain walls) that allow higher or lower coverages. It is not entirely straightforward to experimentally distinguish the periodic domain structures from the incommensurate structures. Therefore, many structures are found labeled as incommensurate in the literature, even though they are probably of the periodic-domain type.

An incommensurate relationship exists when there is no common periodicity between an overlayer and the substrate. This structure is dominated by adsorbate-adsorbate interaction rather than by adsorbate-substrate interactions. An example of incommensurate lattice formation occurs frequently when compounds are produced by exposure of an elemental substrate to a gas. Examples are metal oxides, nitrides, carbides and silicides. As soon as about one or two monolayers of the compound form on the surface, they frequently adopt their own lattice constant independently of the substrate lattice constant. This is because the attractive forces within the compound can be much stronger than those between the compound and the substrate.

(ii) Effects of adsorbate coverage. The surface coverage of an adsorbate is an important parameter in the ordering process. This is because the adsorbate-adsorbate and the adsorbate-substrate forces are strongly influenced by the surface coverage of the adsorbates. (An extreme case is alkali-metal adsorption on transition metal surfaces, where the ionicity of the adsorbate-substrate bond changes as the surface coverage increases.) At very low coverages, adsorbates may bunch together in two-dimensional islands: this occurs when there is short-range attractive adsorbate-adsorbate interactions, coupled with easy diffusion along the surface. Within each island the interactions induce an ordered arrangement of adsorbates. Other adsorbates repel each other at close adsorbate-adsorbate separations, and do not interact at the large separations: these are disordered at low coverages. But when their coverage is increased so that the mean interadsorbate distance decreases to about $5\text{--}10\text{\AA}$, the repulsive interactions induce and strongly influence ordering, favoring certain adsorbate configurations over others. As a result, the structure can also develop a unit cell that repeats periodically across the surface. This is most clearly evident in the low-energy electron diffraction patterns, which depend directly on the size and orientation of this unit cell.

Most adsorbates (other than some metals) will not compress into a one-monolayer overlayer on the closest-packed metal substrates. There appears to be a close-range repulsive force that keeps them apart by approximately a Van der Waals distance (this does not necessarily imply a Van der Waals interaction, since the strongest contribution to the adsorbate-adsorbate interaction is in this case mediated by the substrate). One may attempt to compress the overlayer further by increasing the coverage, which is done by exposing the surface to the corresponding gas at high pressures. The result is either no further adsorption or diffusion

of the adsorbates into the substrate, forming compounds, or, if the temperature is low enough, formation of multilayers.

(iii) Physical adsorption. When adsorbates are used which physisorb rather than chemisorb (at suitably low temperatures), one also finds that the Van der Waals distance determines the densest overlayer packing. Here it is the Van der Waals force acting directly between the adsorbates that dominates. In this case, the optimum adsorbate-substrate bonding geometry can be overridden by the lateral adsorbate-adsorbate interactions, yielding for example incommensurate structures where the overlayer and the substrate have independent lattices. Furthermore, with physisorption a larger coverage is also possible through multilayer formation.

(iv) Metallic adsorbates. With metallic adsorbates, on the other hand, closer-packed overlayers can be formed. This is because metallic adsorbate atoms attract each other relatively strongly to form covalent bonds and cluster together with covalent interatomic distances. Thus at submonolayer coverages close-packed islands form. When the atomic sizes of the overlayer and substrate metals are nearly the same, one observes single-monolayer (1×1) structures, in which adsorbate atoms occupy every unit cell of the substrate. With less equal atomic radii, other structures are formed, dominated by the covalent closest packing distance of the adsorbate. These structures may be of the incommensurate type or, more likely, of the periodic-domain type. Beyond one close-packed overlayer, metal adsorbates frequently form multilayers or also three-dimensional crystallites. Alloy formation by interdiffusion is also observed in many cases, even in the submonolayer regime.

B. Surface Restructuring

There are many observations of deviations of a clean surface structure from the structure predicted by a simple truncation of the bulk lattice. Many LEED patterns of clean surfaces listed in Tables I-IV and X deviate from the expected (1×1) pattern. These are relatively drastic cases where atoms may be displaced substantially from their bulk lattice sites and bonded to different atoms than the bulk structure would imply. Such cases are called reconstructions. Another cause of reconstruction is, as seen at compound surfaces, a change in elemental composition at a surface compared to the bulk composition. A different crystalline lattice may become favored as the surface composition changes due to segregation to or from the surface. Non-stoichiometric compounds often exhibit this behavior. A more subtle restructuring has also been discovered during full structural determinations. Layer spacing relaxations have been found between the first few surface layers of the less close-packed clean metal surfaces, e.g., fcc (110) and bcc(100). These relaxations correspond to deviations of the surface bond lengths from the bulk values, but do not affect the LEED pattern.

Among the clean metal surfaces, about a dozen are known to reconstruct. Over 40 clean semiconductor reconstructions are reported. Numerous reconstructions have also been found in the area of oxides and other compounds. (See the LEED patterns of clean surfaces in Tables I-IV, and X.)

Some of these reconstructions and layer spacing relaxations can be explained by the tendency for bond lengths to decrease as the bonding coordination decreases. This trend fits long-established principles, as proposed by Pauling,¹¹ if one relates coordination number to bond order. A good illustration is presented by the

reconstructions of the clean Ir, Pt and Au(100) surfaces. In these three cases, the interatomic distance in the topmost layer shrinks by a few percent parallel to the surface. It then becomes more favorable for this layer to collapse into a nearly hexagonally close-packed layer rather than maintain the square lattice of the underlying layers. Many adsorbates on these surfaces can remove this reconstruction by cancelling the driving force towards smaller bond lengths.

In these studies surface cleanliness is monitored by various techniques including AES, XPS, HREELS, etc., and the sample is cleaned until the concentration of impurities is below the detection threshold of these techniques (a few hundredths of a monolayer). However, it is always risky to conclude that a reconstruction is a property of the clean surface, since it is very difficult to rule out the presence of at least some contaminants. Nevertheless, it is now believed that most of the nominally clean reconstructions are intrinsic properties of the clean surfaces, and are only marginally affected by small levels of impurities. This is the case of the Ir, Pt and Au(100) surfaces mentioned above.

At the same time it is also known that a fair number of reconstructions are adsorbate-induced. Even without being ordered, an adsorbate can induce a reconstruction, as happens with H on W(100). The clean W(100) crystal surface is itself already reconstructed, but hydrogen changes it further to another structure that varies smoothly with the hydrogen coverage. Often, the adsorbate fits periodically within the unit cell of the reconstructed substrate. This occurs, for example, with carbon on Ni(100) and sulfur on Fe(110), where the metal exhibits relatively minor, but interesting adsorbate-induced distortions.

Adsorbates can also restructure stepped surfaces. For example, oxygen deposited on stepped Pt surfaces has been observed to produce double-height steps. Facetting has also been observed under such circumstances.

By contrast, it is also possible, with contaminants or otherwise, to generate a metastable unreconstructed phase from a reconstructed clean surface. With suitable contaminants, such phases have been achieved with all reconstructed surfaces. In some cases, e.g., Ir(100), clean metastable structures can be obtained by appropriate heat treatments. Si(111)-(1×1) metastable unreconstructed structure can also be achieved by laser-annealing and rapid cooling processes which freeze the unreconstructed structure which is stable at high temperature.

In the case of alloys, surface segregation can lead to new ordered arrangements, through a change in the surface composition. In some cases, for instance CuAl(111) with a bulk composition of 16% of Al, the surface alloy orders while the bulk alloy has no long-range order. Such cases are reported in our tables as having a superlattice (e.g., for the above-mentioned CuAl case), by reference to the (1×1) lattice of the pure majority element. One may call these alloy reordering reconstructions. They involve essentially normal lattice sites, but a different ordering at the surface compared to the bulk.

Semiconductors almost universally reconstruct when clean. This is due to the difficulty of their surface atoms to compensate for the loss of nearest neighbors, since bonding is relatively directional in semiconductors. The "dangling bonds" left by the absence of bonding partners cannot easily be used for bonding to existing surface atoms, except through more drastic rearrangements of these atoms. Therefore, most semiconductor surfaces reconstruct. Major rebonding between surface atoms occurs in this process. The associated perturbation propagates several layers into the surface until the bulk lattice is recovered. The silicon

surfaces in particular have been extensively studied in their various reconstructed forms. The famous Si(111)-(7×7) structure has not yet been solved, but so much information has been gathered, including real-space topographies of this surface obtained with STM, that a good qualitative picture of its structure is becoming apparent.¹² Again with semiconductor surfaces, adsorbates can negate the need for reconstruction and induce a return to the bulk structure. This can happen by bonding of the adatoms to the "dangling bonds." Hydrogen does this particularly well and to some extent chemically passivates the resulting surface. More frequently, however, adsorbates become part of a new compound structure, by penetrating within the few topmost substrate layers.

The stoichiometry is also important in considering the reconstruction of compound semiconductors. For example a $(\sqrt{5} \times \sqrt{5})R26.6^\circ$ structure of BaTiO₃(100) surface observed after high temperature annealing is considered to be due to the ordering of lattice vacancies at the surface. Another example is the GaAs(100) surface which presents various reconstructed structures as the Ga to As ratio changes. Relatively little structural knowledge has been accumulated so far on this subject, despite the great technological importance of semiconductor surfaces and the semiconductor-metal interface.

C. Simple Structures of Atomic Adsorbates at Metal Surfaces

By simple structures we mean clean unreconstructed metal surfaces with low Miller indices and atomic adsorbates thereon. These were the mainstay of the early LEED studies and constituted the bulk of earlier tabulations. In recent years this class of structures has continued to grow, mostly through new combinations of substrates and adsorbates.

The clean unreconstructed metal surfaces, by definition, have the structure expected from a simple truncation of the bulk lattice. For close-packed surfaces with low Miller indices, relaxations from the bulk atomic positions have been found to be less than about 0.02Å by various crystallographic methods, especially, LEED and MEIS or HEIS. For the more open surfaces, such as fcc(110) and bcc(100), somewhat larger relaxations have been observed, as mentioned in the previous section.

The simple atomic adsorption structures on metal surfaces are characterized by the occupancy of high-coordination sites. (Physisorption behaves differently and will be discussed in Section 4.H). Thus Na, S, and Cl overwhelmingly adsorb over "hollows" of the metal surface, bonding to as many metal atoms as possible. The situation is slightly more complicated with the smaller adsorbates, H, C, N, and O. Although high coordination is still preferred, the small size of these atoms often allows penetration within or even below the first metal layer. The penetration can be interstitial or substitutional. In either case the metal surface can reconstruct as a result.

D. Metallic Monolayers on Metal Crystal Surfaces

Table V lists surface structures of metal monolayers adsorbed on metal surfaces. Data on more than 400 systems have been reported so far.

At low coverages, most of the metallic adsorbates form commensurate ordered overlayers: the overlayer unit cells are closely related to the substrate unit cells. Furthermore, in many cases a (1×1) LEED pattern is observed. This suggests that adsorbed metal atoms attract each other to form 2-dimensional islands. The

size of such islands can change depending on the substrate temperature, which can be detected by measuring the LEED spot size. A disordered LEED pattern is observed when the adsorbed metals repel each other. This is observed for example in the case of alkali metal adsorption on a transition metal, since the charged adatoms undergo repulsive interactions.

At higher coverages, the relative atomic sizes of the different metals becomes an important factor. When the atomic sizes of the substrate and adsorbate metals are similar, (1×1) structures are favored, whereas coincidence structures often form when the atomic sizes are much different. As the overlayer coverage increases towards saturation of a monolayer, the adsorbate-adsorbate interaction increases. Then an incommensurate hexagonal overlayer with interatomic distances close to the bulk value of the adsorbate appears to form. Another, perhaps more satisfactory interpretation of the LEED patterns yields an overlayer structure with out-of-phase domains, reflecting the remaining strength of the substrate-adatom interaction. In the case of strong adatom-adatom attraction and weak substrate-adatom attraction, one observes the independent superposition of the structures of the pure adsorbate and the pure substrate. Often such dense overlayers have a lattice that is slightly rotated with respect to the substrate lattice. This has also been experimentally observed and theoretically predicted for physisorbed films,¹³ and is called "orientational epitaxy."

Under higher exposure some metals can undergo layer-by-layer growth, while several systems, such as Fe on W(110), form 3-dimensional crystallites. Most cases fall between these two extremes. Comparison of the surface tension of the adsorbate metal and of the substrate metal has failed to explain these phenomena, and up to now there is no simple rule to predict which metal film growth mechanism applies.

When a metal undergoes (1×1) epitaxial growth with a substrate lattice constant that differs from its own bulk lattice constant, the overlayer metal can be considerably strained. Therefore, the epitaxial growth must at some point be accompanied by a lattice constant change. Such a change is probably accompanied through dislocations occurring within a dozen layers from the interface.

Alloy formation is frequently observed with suitable combination of metals, usually at higher temperatures. However very little surface crystallographic data is available on such systems, and a general trend cannot be drawn at this time.

E. Alloy Surface Structures

Our Tables include about 90 surface structures of alloys, including both clean and adsorbate-covered surfaces. These are brought together in Table VI. Alloys have the special property that their surface composition can differ considerably from their bulk composition. Other compounds share this property, but the frequently easy interdiffusion in alloys stands out. Indeed, some recent studies have found substantial surface segregation. In some cases the surface composition can even oscillate from one atomic layer to the next near a surface. Furthermore, adsorbates may radically modify this surface composition. Much work is needed to clarify these issues.

The LEED pattern informs about the surface ordering. It is found that some alloys retain their bulk ordering at the surface. For instance, Ni_3Al , as well as other Cu_3Au -type alloys, have a (100) face which exhibits the periodicity expected from the alternating bulk stacking of 50-50 mixed NiAl layers and of pure Ni layers. (Some authors refer to these surface structures as $c(2 \times 2)$; we prefer the notation (1×1) since the bulk periodicity is not changed.)

Other alloys, exemplified by Cu-rich CuAl, are disordered in the bulk, but order at some faces. Thus the (111) face of α -Cu-16at%Al exhibits a $(\sqrt{3} \times \sqrt{3})R30^\circ$ surface periodicity (relative to the (1×1) surface lattice of pure Cu(111)). The other low-Miller-index faces of this alloy do not order.

F. Organic Adsorbates

Around 390 LEED structures are reported in Table VII, dealing with the adsorption of organic molecules. By far the most frequently studied substrates are metals, with only a dozen cases of semiconductors or insulators. Platinum substrates have been most extensively used, due no doubt to their importance in both heterogeneous catalysis and electrochemistry. The most common adsorbates in this table are C_2H_2 (acetylene), C_2H_4 (ethylene), C_6H_6 (benzene), C_2H_6 (ethane), $HCOOH$ (formic acid), and CH_3OH (methanol), reflecting the same technological applications.

Most organic adsorption studies have been carried out near room temperature, with frequent cursory explorations of the higher-temperature behavior. Especially with organics, temperature is a crucial variable, given the frequently diverse reaction mechanisms that can occur when molecules interact with surfaces. A number of studies have explored the lower temperatures, especially with the relatively reactive metal surfaces to the left of the Periodic Table, such as Fe, Mo, and W. At higher temperatures, decomposition of molecules is the rule. With hydrocarbons sequential decomposition has been studied in greatest detail with the help of HREELS vibrational analysis.

The LEED patterns generally reflect disorder at high temperatures. Exceptions occur especially with carbon layers resulting from the decomposition of organic adsorbates: these may form either carbidic chemisorbed layers that are ordered or graphitic layers that have characteristic diffraction patterns.

Ordered LEED patterns for organic adsorption are frequent at lower temperatures. They can often be interpreted in terms of close-packed layers of molecules, consistent with known Van der Waals sizes and shapes. These ordered structures usually are commensurate with the substrate lattice, indicating strong chemisorption in preferred sites. It appears that many hydrocarbons lie flat on the surface, using unsaturated π -orbitals to bond to the surface. By contrast, non-hydrocarbon molecules form patterns that indicate a variety of bonding orientations. Thus CO is found to strongly prefer an upright orientation. However, upon heating unsaturated-hydrocarbon adsorbates evolve hydrogen and new species may be formed which bond through the missing hydrogen positions. An example is ethylidyne, CCH_3 , which can be formed from ethylene, C_2H_4 , upon heating. Ethylidyne has the ethane geometry, but three hydrogens at one end are replaced by three substrate atoms.

G. Coadsorbed Surface Structures

Table VIII brings together surface structures formed upon coadsorption of two or more different species. Listed are ~ 150 structures. In general, coadsorbed surface structures may be classified in two categories: cooperative adsorption and competitive adsorption. In cooperative adsorption, the two kinds of adsorbate mix well together and interpenetrate. In competitive adsorption the adsorbates segregate to form separate non-mixed domains. For example, addition of CO to a preadsorbed (2×2) oxygen layer on Pd(111) eventually forms a mixed CO+O phase (cooperative adsorption). On the other hand, addition of O_2 to a

preadsorbed CO layer (at low coverages: $\theta < 0.33$) on Pd(111) forms separate domains of O and of CO (competitive adsorption). Therefore, in this instance the order of adsorption affects the reactivity towards CO₂ formation.

Coadsorption structures have been extensively examined on Rh(111), Pt(111), and Pd(111) using various pairs of adsorbates from the set C₂H₂, C₂H₃ (ethynylidyne), C₆H₆, Na, CO, and NO. Among these, the hydrocarbons and Na transfer electrons to Rh(111) when adsorbed: they are donors. CO and NO have the opposite electron-transfer character, and are therefore acceptors. It has been observed that long-range ordering of the mixed layer requires the coadsorption of an electron donor with an acceptor. Donor-donor and acceptor-acceptor combinations are either disordered or segregate into separate regions. The combination of donor and acceptor seems to stabilize the mixed cooperative phase. Then each donor adsorbate surrounds itself with acceptors, while each acceptor surrounds itself with donors. This is analogous to the three-dimensional ionic lattices which also exhibit great stability.

As an illustration, on Pd(111) and Pt(111), benzene molecules adsorb in a disordered manner at room temperature. However, addition of CO to these disordered overlayers produces ordered surface structures.

H. Physisorbed Surface Structures

At low enough temperatures most gas-phase species will physisorb on many surfaces. In many instances, the physisorbed state is short-lived (lifetime well below a second), because of a low barrier to a chemisorbed state. With inert gases and with saturated hydrocarbons, however, physisorption is commonplace and stable on many types of substrate. These substrates include metals as well as inert surfaces such as the graphite basal plane. Also, more reactive species such as O₂, CO and NO physisorb stably on the graphite basal plane. We shall focus our discussion on this type of relatively stable physisorption. Over 60 such structures are listed in Table IX. Little is known about the structure of the less stable short-lived physisorbed species, despite their obvious importance as precursors to chemisorbed species.

In physisorption the adsorbate-adsorbate interactions are usually comparable in strength to the adsorbate-substrate interactions, all of which are dominated by the Van der Waals forces. With stable physisorption, there is no chemistry to perturb the adsorbates over large ranges of temperature and coverage. One can therefore examine large parts of the phase diagrams of these adsorption systems.

Many phases have been observed in physisorption, and new classes of phases continue to be discovered. There are commensurate and incommensurate phases, disordered lattice-gas and fluid or liquid phases. There are out-of-phase domain structures, including striped-domain phases, pinwheel and herringbone structures, and modulated hexatic reentrant fluid phases, among others.⁴ Relative to chemisorption and its more complex interactions, physisorption has the advantage that simpler theories can be set up to describe the phase diagrams. The two-dimensional nature of the problem has especially helped the general theory of phase transitions, because many models can only be solved in two dimensions.

From the point of view of physisorption phases, one should distinguish between the ordering of the positions and the orientations of the adsorbed species. With spherically symmetrical species like inert gases this is not an issue, but all molecules do offer the additional degrees of orientational freedom, which freeze in at

different temperatures than does the positional ordering. This adds considerable richness to the phase diagrams.

The simpler among the observed LEED patterns for physisorbed species can often be easily interpreted in terms of structural models. The known Van der Waals sizes of the species leads to satisfactory structures which are more or less close-packed. This is especially straightforward with inert gases. With molecules, the best structural models usually involve flat-lying species, which are arranged in a closest-packed superlattice. The flat geometry provides the greatest attractive Van der Waals interaction with the substrate.

I. High—Miller—Index (Stepped) Surface Structures

Over 380 surface structures have been observed on the high-Miller-index surfaces, see Table X. About 250 of these were reported during the past six years, which clearly indicates a fast growing interest in this field. In this period, much work has focussed on the clean and chemisorbed structure of high-Miller-index semiconductor surfaces. In particular, very interesting reconstructions of the various high-Miller-index Si, Ge and GaAs surfaces have been observed.

Most of the stepped surfaces reported in Table V have close-packed terraces separated by steps of one atomic height. Many ordered overlayer structures on these one-atomic-height stepped surfaces have been reported. The observed LEED patterns indicate a strong dependence on the width of the terraces. With wide terraces, adsorbates often order as if no steps were present, i.e., as on the low-Miller-index surface. When the terraces become narrow, the adsorbates are strongly affected by the steps. For instance, carbon monoxide adsorbs with (2×2) and $(\sqrt{3} \times \sqrt{3})R30^\circ$ patterns on $\text{Rh(S)}-[6(111) \times (100)]$, which has (111) terraces six atoms wide separated by (100) oriented steps. These two patterns are also observed on $\text{Rh}(111)$. But for the case of $\text{Rh}(331)$ with (111) terraces three atoms wide, quite different structures for chemisorbed CO have been observed.

Another important observation is that reconstructions of the high-Miller-index surfaces are frequently induced by the adsorption of O_2 , H_2 , etc. Examples include: ReO_3 compound formation on the oxygen covered $\text{Re(S)}-[6(0001) \times (16\bar{7}6)]$ surface; new facet formation on the $\text{Ni}(210)$ surface after the adsorption of O_2 ; facet formation due to the decomposition of hydrocarbons on various Pt and Rh high-Miller-index surfaces; and graphite formation or faceting on $\text{Pt(S)}-[4(111) \times (100)]$ after the total dehydrogenation of ethylene or benzene on this surface. These restructuring phenomena can often be ascribed to the formation of a stable new phase like oxide, carbide, and nitride. The study of the surfaces of oxide-, carbide- and nitride-solids will help understand the restructuring phenomena observed on the stepped surfaces.

A comment about the superlattice notation for stepped surfaces: an adsorbate superlattice designation like (2×2) is meant to imply a superlattice relative to the close-packed lattice within a terrace, rather than relative to the step-to-step repetition distance.

5. Future Directions

The solid surface presents a two-dimensional world where molecules may order and interact differently from that in three dimensions. Surface restructuring of many solids when clean either by relaxation or by reconstruction clearly indicates this. When investigating polyatomic solids, compounds or alloys, the surface

composition will also be different than the bulk composition to provide an additional important variable that alters the surface structure; non-stoichiometry.

We should mention several monoatomic solids including boron, manganese and uranium that escaped the attention of surface scientists. However, future studies clearly will focus on surfaces of increasing chemical complexity. These include high-Miller-index (stepped) surfaces, and the surface structures of diatomic and polyatomic solids, the oxides, sulfides, carbides, nitrides, silicates, carbonates, as well as alloys. Many more adsorption structures will also be explored on semiconductor surfaces. Organic molecules of increasing size will be investigated and it is very likely that the surfaces of organic solids will be the subjects of structural studies as they are most important in the biosciences and chemical technologies. Coadsorption will continue to expand as an area of interest for the study of chemical reactions including the effects of promoters and inhibitors. Underexplored adsorbates include inorganic molecules (with the exception of CO and NO). Also semiconducting materials are rarely deposited on metals, while metals are currently very much studied on semiconducting substrates.

One interesting observation recently has been the ordering of adsorbed monolayers at low temperatures as low as 30 K for CO and 60 K for C₂H₂ on close-packed metal surfaces.¹⁴ This finding indicates the low activation energy for surface diffusion as compared to desorption of these molecules. It is likely that adsorbate surface structures will be studied increasingly at low temperatures as a consequence.

Rapid dynamical surface structure calculations have become possible due to recent developments of simplified computational techniques.¹⁵ This way the precise locations of atoms and molecules in the surface unit cells can be determined. The surface structures listed in Tables I-X are excellent candidates for surface crystallography investigations. It is hoped that a large number of them will be scrutinized by LEED crystallography in the near future so that we can improve our understanding of the surface chemical bonds in atomic and molecular monolayers.

Acknowledgements

We thank Morgan Edwards for assistance in organizing LEED data during the early stages of tabulation. This work was supported by the Director, Office of Basic Energy Science, Materials Science Division of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098. H. Ohtani gratefully acknowledges financial support from IBM Japan.

References

1. G. A. Somorjai and F. J. Szalkowski, *J. Chem. Phys.* 54, 389 (1971).
2. D. G. Castner and G. A. Somorjai, *Chem. Rev.* 79, 233 (1979).
3. J. P. Bibérian and G. A. Somorjai, *J. Vac. Sci. and Tech.* 16, 2073 (1979).
4. M. A. Van Hove, W. H. Weinberg, C.-M. Chan, *Low-Energy Electron Diffraction: Experiment, Theory, and Structural Determination*, Springer-Verlag, Berlin (1986).
5. R. J. Rous, J. B. Pendry, D. K. Saldin, K. Heinz, K. Müller, and N. Bickel, *Phys. Rev. Lett.* 57, 2951 (1986).

6. (a) L. L. Kesmodel and G. A. Somorjai, *Acc. Chem. Res.* 9, 392 (1976).
 (b) G. A. Somorjai, *Principles of Surface Chemistry*, Prentice-Hall, Englewood Cliffs, N.J. (1972).
 (c) G. Ertl and J. Küppers, *Low Energy Electrons and Surface Chemistry*, Verlag Chemie, Weinheim (1979).
7. L. De Bersuder, *Rev. Sci. Instr.* 45, 1569 (1974).
8. (a) P. C. Stair, *Rev. Sci. Instr.* 51, 132 (1980).
 (b) E. G. McRae, R. A. Malic, and D. A. Kapilow, *Rev. Sci. Instr.* 56, 2077 (1985).
 (c) D. F. Ogletree, Ph.D. Thesis, Physics Department, University of California, Berkeley (1986).
 (d) D. F. Ogletree and G. A. Somorjai, to be published.
9. B. Lang, R. W. Joyner, and G. A. Somorjai, *Surf. Sci.* 30, 454 (1972).
10. M. A. Van Hove and G. A. Somorjai, *Surf. Sci.* 92, 489 (1980).
11. L. Pauling, *The Nature of the Chemical Bond*, 3rd Ed., Cornell University Press, New York (1960).
12. (a) K. Takayanagi, Y. Tanishiro, S. Takahashi, and M. Takahashi, *Surf. Sci.* 164, 367 (1985).
 (b) R. J. Hamers, R. M. Tromp, and J. E. Demuth, *Phys. Rev. Lett.* 56, 1972 (1986).
13. C. G. Shaw, S. C. Fain, Jr., and M. D. Chinn, *Phys. Rev. Lett.* 41, 955 (1978).
14. C.-T. Kao, G. S. Blackmann, and G. A. Somorjai, to be published.
15. (a) M. A. Van Hove, R. J. Koestner, J. C. Frost and G. A. Somorjai, *Surf. Sci.* 129, 482 (1983).
 (b) M. A. Van Hove, R. F. Lin and G. A. Somorjai, *Phys. Rev. Lett.* 51, 778 (1983).

TABLE I. Surface Structures on Substrates with One-fold Rotational Symmetry†

Substrate	Adsorbate	Surface Structure	Reference
(Al,Ga)As(110)	[clean]	(1×1)	1375
AlP(110)	[clean]	*(1×1)	1521,1863*
CdTe(110)	[clean]	*(1×1)	1367,1382*,1495 1504,1620
CoSi(100)	[clean]	(2×1)	1312
CoSi ₂ (100)	[clean]	(1×1)	1312
GaAs(110)	[clean]	*(1×1)	896,949,1008,1090,1124,1182 1449,1480,1519 1524,1567,1572 1575,1576,1702* 1764*,1765!
	Ag	(2×2) (1×1) [001] Streaks c(4×4) [Multilayer]	1567 1575 1575 1344
	Al	(1×1)	1375,1432,1607
	Al (low coverage)	*(1×1)-Al	1871*
	Al (medium coverage)	*(1×1)-Al	1871*
	Al (high coverage)	*(1×1)-Al (1×4) [Multilayer]	1871* 1344
	As	(1×1)	579,1375
	Au	Disordered	1008
	Cu	Polycrystalline	1182
	Ga	Polycrystalline	1305
	Ge	(1×1) [Multilayer] (1×1)-Ge (3×1)-Ge (2×1)-Ge (3×1)+(1×4) with Streaks (1×1)+Blurred (8×10)	1432 1089,1520,1572 588 588 1089 1089
	H ₂ O	(1×1)	1006
	In	(1×1)	1432
	Fe(CO) ₅	Facet{100}	1377
	O ₂	Disordered	744
	Pd	Disordered	1008
	Sb	*(1×1)-Sb	1320,1367,1383 1424,1442*
	ZnSe	(1×1) (1×2)	1444 1444
GaP(110)	[clean]	*(1×1)	819,1445*,1495 1521,1619
	Al	AlP(110) (1×1)	1426 1521
GaSb(110)	[clean]	*(1×1)	1378*,1420*,1766!
InAs(110)	[clean]	*(1×1)	1423*
InP(110)	[clean]	*(1×1)	1495,1521,1568 1570,1573,1618* 1784*
	Al	(1×1) (1×1) Diffuse	1521 1570
	Cl ₂	Disordered	1660

†Organic overlayer structures and high-Miller-index surface structures are not included. See Table VII and Table X, respectively, for these structures.

TABLE I. Surface Structures on Substrates with One-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
InSb(110)	Cu	(1×1)	1568
	H ₂ O	Ordered	1573
		Disordered	1573
	Ni	Disordered	1568
	[clean]	*(1×1)	1181,1420,1888*
Te(10 $\bar{1}$ 0)	Sn	Amorphous	1181
	[clean]	*(1×1)	1801*
ZnO(10 $\bar{1}$ 0)	[clean]	*(1×1)	1104,1239,1612
			1772*
	H ₂ O	Disordered	1104
	O ₂	(1×1)-O	392
	Xe	Hexagonal	1026
		Disordered	1026
ZnO(11 $\bar{2}$ 0)	[clean]	*(1×1)	1772*
ZnS(110)	[clean]	*(1×1)	1445*
ZnSe(110)	[clean]	*(1×1)	1478*
ZnTe(110)	O ₂	ZnO(000 $\bar{1}$)	642
	[clean]	*(1×1)	1378*,1495,1504

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry[†]

Substrate	Adsorbate	Surface Structure	Reference
Ag(110)	[clean]	*!(1×1)	707,888,1522,1534 1750!,1751,1872*
	Br ₂	(2×1)-Br	888
		c(4×2)-Br	888
		AgBr	888
	C ₂ N ₂	Disordered	407
	Cl ₂	Adsorbed	732
	Cs	(1×2)	859,1534
		(1×3)	859,1534
	HCN	Disordered	407
	H ₂ O	Disordered	878
	H ₂ O+Li ⁺	Complex	1557
	H ₂ S	(3×2)-S	627
		c(10×2)-S	627
		(3×4)-S	627
	I ₂	Pseudo-hexagonal-I	1145
		c(2×2)-I	1145
	K	(1×2)	1534
		(1×3)	1534
	Li	(1×2)	1534
	Na	(1×1)	489
	NO	Disordered	345
	O ₂	!(2×1)-O	146,341,342,343 344,695,878,943 974,1027,1047 1140,1143,1160 1300,1690,1751!
		(1×2)-O	1376
		(3×1)-O	146,341,342,343 695,878,974,1143 1160,1300,1690
		(4×1)-O	146,341,342,878 974,1143,1300 1690
		(5×1)-O	146,341,695,1300
		(6×1)-O	146,341,1300
		(7×1)-O	146
		c(6×2)-O	974
		(2×2)	1143
		c(6×2)-SO ₃	1027,1371
		(1×2)-SO ₄ etc.	1371
		(1×2)-OH	878
		(1×3)-OH	878
		(1×2)-SO ₂	1027,1371
		c(4×2)-SO ₂	1027,1371
		(1×1)	1371
		$\begin{pmatrix} 2 \\ 3 & 1 \\ 4 & 0 \\ 3 \end{pmatrix}$ -SO ₂	1027
	Xe	Hexagonal Overlayer	159

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Al(110)	[clean]	$(1 \times 1) + (1 \times 2)$	965
		$*(1 \times 1)$	1354, 1409*, 1464 1498, 1566*, 1721*
	CO	Not Adsorbed	1273
	O ₂	(331) facets	123
		(111) facets	122
Au(110)	[clean]	Disordered	709
		$*(1 \times 2)$	754, 1009, 1098, 1166 1752*
		$(1 \times 2) + (1 \times 1)$	965
	Bi	(1×3)	754, 1098
		$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	498
		$\begin{pmatrix} 2 & 1 \\ -1 & 1 \end{pmatrix}$	498
		(2×1)	498
	H ₂ S	$(1 \times 2) - S$	251
		$c(4 \times 2) - S$	251
	Pb	(1×3)	444, 495, 683
		(1×1)	444, 495, 683
		(7×1)	444, 495, 683
		(7×3)	444, 495, 683
		(4×4)	444, 495, 683
C(10 $\bar{1}$ 0)	[clean]	$c(2 \times 2/3)$	1033
C(110), diamond	O ₂	Not Adsorbed	164
	N ₂	Not Adsorbed	164
	NH ₃	Not Adsorbed	164
	H ₂ S	Not Adsorbed	164
CdTe(100)	[clean]	$(3 \times 1), (1 \times 1), [110]_f$	1393
Co(10 $\bar{1}$ 0)	O ₂	$(2 \times 1) - O$	1070
Co(11 $\bar{2}$ 0)	[clean]	$*(1 \times 1)$	1197, 1768, 1848*
		$(3 \times 1) - CO$	902
		Disordered	902
	H ₂ O	Disordered	1310
		$(4 \times 1) - O$	1310
		Complicated	1310
		(1×1)	1343
Cr(110)	[clean]	Disordered	1343
		CO	
	Br ₂	$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	1016
		$\begin{pmatrix} 1 & \frac{1}{1+X} \\ -1 & \frac{2}{1+X} \end{pmatrix} - Br (0 < X < 1/3)$	1016
		$\begin{pmatrix} 1 & 1 \\ -2 & 2 \end{pmatrix} - Br$	1016

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Cu(110)	O ₂	(3×1)-O	140
		(100) facets	140,256
		Cr ₂ O ₃ (0001)	140,256
		Cr ₂ O ₃	1261
		Disordered	1261
		(1×1)	725,925,995,1023,1131
			1135!,1136*,1436
			1498,1723*
	Au	$\begin{pmatrix} 1 & 0 \\ -1/2 & 3/2 \end{pmatrix}$	479
		(1×2)	479
		(2×2)	479
		Complex Structures	479
		Br ₂	c(2×2)
		Br(a)+H ₂ O	(3×2)
		C	Disordered
		C+O ₂	(2×1)
		CO	Ordered 1D
			(2×3)-CO
			(2×1)-CO
			c(5/4×2)
			c(1.3×2)-CO
		Hexagonal Overlayer	255
		H ₂	Not Adsorbed
		H ₂ O	Disordered
			Not Specified
			c(2×2)-H ₂ O
			c(2×2)
			(2×1)-OH
			(1×1)-H ₂ O
		H ₂ S	c(2×3)-S
			Adsorbed
Ni(CO ₄)+CO	I ₂		35
			35
			572,1915!
	Kr	!c(2×2)-I	1915!
		!c(2×2) Compressed	1304,1331
	N ₂ O	c(2×8)-Kr	1331
		Quasiperfect Hex.	879
	Ni(CO ₄)+CO	(2×1)-O	1048
		(1×1)+Disordered	7,8,9,45,46,246
	O ₂	!(2×1)-O	656,750,879,885
			920,953,982,1053
			1066,1076,1095
			1257,1285,1695
			1916!,1917!,1918!
			1270
		c(2×1)-O	1023
		Streaks along <110>	656,885
		(1×1)-O	885
		(3×1)-O ₂	

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Cu/Au(110)	O(a)+CO O(a)+H ₂ O	c(6×2)-O	8,9,45,46,246,656 885,920,1066,1076 1095,1257,750,953 1285,1695
		(5×3)-O	8,115
		c(14×7)-O	1332
		Disordered	1066
		(2×1)-O,H ₂ O	1023
		c(2×2)-O,H ₂ O	1023
		(2×1)-H ₂ O	1270
		(1×1)-H ₂ O,OH	1270
		(2×1)-OH,O	1270
		$\begin{pmatrix} 1 & 1 \\ -1 & 1 \end{pmatrix}$	481,482
	Pb	(5×1)	481,482
		(4×1)	482
		(2×1)-Pd	726
		(1×1)-Pd	726
	Xe	c(2×2)-Xe	159,1331,1611
		Hexagonal Overlayer	159,1611
		Pseudo-Hexagonal	1331
	[clean]	Streak	737
		(1×2)	737
		Complex Pattern	737
		c(3×1)	737
Cu/Ni(110)	CO	(2×2)	737
		(2×1)-CO	134
		(2×2)-CO	134
		(1×2)-CO	787
	H ₂	(1×3)-H	787
	H ₂ S	c(2×2)-S	134
Cu(110)-Ni(1°)	O ₂	(2×1)-O	134,872
		(2×2)-O	872
		(2×1)-O	1311
		c(6×2)-O	1311
Cu/Pd(110)	[clean]	(2×1)	737
Cu-25% Zn(110)	[clean]	(1×1)	1152
Fe(110)	O ₂	Disordered	1152
	[clean]	* (1×1)	1015,1639*
	CO	$\begin{pmatrix} 3 & -2 \\ 0 & 4 \end{pmatrix}$ -CO	346
		c(2×4)	810
		(1×2)	810
		c(2×2)	687
		(1×4)	687
	CO ₂	$\begin{pmatrix} 4 & 0 \\ -1 & 3 \end{pmatrix}$	687
		c(2×2)	687
		(1×4)	687

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		$\begin{pmatrix} 4 & 0 \\ -1 & 3 \end{pmatrix}$	687
	Fe ₃ O ₄	Not Well Ordered	1189
	H ₂	* (2×1) -H	177,1753*
		* (3×1) -2H	177,1753*
		(1×1) -H	177
		$c(2 \times 2)$ -H	687,1298
		(3×3) -6H	1298
		$\begin{pmatrix} 1 & -1 \\ 1 & 2 \end{pmatrix}$	687
	H ₂ S or S	(2×4) -S	114
		(1×2) -S	114
		* (2×2) -S	836,1000,1015,1608*
		$c(3 \times 1)$ -S	836
		$c(18 \times 3)$ -S	836
	K	Hexagonal Array	728
	K+O ₂	$c(4 \times 2)$	786
	N ₂	$\begin{pmatrix} 3 & -2 \\ 0 & 4 \end{pmatrix}$ -N ₂	346
	NH ₃	(2×2)	687
		Disordered	1686
		$\begin{pmatrix} 4 & 1 \\ -3 & 3 \end{pmatrix}$	687
	O ₂	(2×2) -NH	1686
		$c(2 \times 2)$ -O	87,88,99
		(2×2) -O	1015
		$c(3 \times 1)$ -O	87,88,99
		(2×8) -O	98
		FeO(111)	87,88,99,269
		(2×1) -O	141
		(5×12) -O	1664
Fe/Cr(110)	O ₂	Cr ₂ O ₃ (0001)	280
		Amorphous Oxide	279
Ge(110)	[clean]	$c(8 \times 10)$	804,1683
		Ge(17,15,1)- (2×1)	804,1683
	H ₂ S	(10×5) -S	178
	O ₂	Disordered	17,18
		(1×1) -O	17,18
GaAs(100)	[clean]	(2×4)	1085,1090,1274,1387
		(4×2)	1274
		$c(4 \times 4)$	697,1085,1240
			1387,1541
		(4×6)	697,1090,1213,1240
			1377,1448,1541
		$c(6 \times 4)$	697
		(1×1)	1213,1519
		(2×8)	1449
		$c(2 \times 8)$	697,1090,1213,1240
			1541

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
GaAs(100)-As rich GaAs(100)-Ga rich GaP(100)		c(8×2)	697,1090,1213,1448
			1541
		(8×2)-Ga	1519
		(1×2)	1448
		(1×6)	697,1541
	[laser process]	(1×1)+steps	1446
	Ag	c(8×2)	710
		c(2×8)	710
		c(4×4)	710
		c(6×6) [Multilayer]	1344
	Al	c(8×2)	710
		c(2×8)	710
		c(2×2) [Multilayer]	1344
	As ₄	c(4×4)	1422
	As ₄ ,Ga	(2×4)	1365
		(4×6)	1365
		c(8×2)	1365
		(4×1)	1365
		(3×1)	1365
	Fe(CO) ₅	(1/√2×1/√2)R45° [Multilayer]	1377
	Bi	(1×1)-Bi	1491
		(1×2)-Bi	1491
		(3×1)-Bi	1491
		(8×2)-Bi	1491
	Ge	(1×2)-Ge	1213
		(1×2)+(2×1)	1213
	H ₂	(1×1)	1541
	H ₂ S	c(2×8)-H ₂ S	589
		(2×1)	589
	HCl,H ₂ O	(1×1)	1518
	Pb	(1×4)-Pb	1387
	Pb,As ₄	(1×2)-Pb	1387
	Sn	(1×3)-Sn	1387
	Sn	(1×2)-Sn	1387
	[clean]	c(4×4)	1214,1524
	[clean]	(4×6)	1214,1524
	[clean]	(4×2)	694
	Cs	(1×4)-Cs	694
		(7×1)-Cs	694
		(1×4)-Cs	694
	PH ₃	(1×2)	694
	Si	(2×1)	1554
Ge(110)	H ₂ S	(10×5)-S	178
	O ₂	Disordered	17,18
		(1×1)-O	17,18
InP(100)	[clean]	(4×2)	1170,1384
	[laser annealed]	(1×1)	1170,1384
	[laser annealed]	(1×1)+steps	1446
InSb(001)	Sb	*(1×1)	1919*,1920*
	[clean]	c(2×8)	1159,1421
	Sn	α-Sn(001)-(2×1)	1159
Ir(110)	[clean]	*(1×2)	701*,1321,1665
		(1×1)	1787,1875
			1786*

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
LaB ₆ (110)	CO	(2×2)-CO	347,348
		(4×2)-CO	348
	H ₂	(1×2)	830
		Adsorbed	347
	H ₂ O	Adsorbed	615
	H ₂ S	*(2×2)-2S	715,1875*
		(1×2)-S	715
		c(2×4)-S	715
	N ₂	(1×2)	678
		(2×2)-N ₂	678
		Not Adsorbed	347
	NO	Disordered	677
		Streaks	677
	O ₂	(1×2)-O	347,1687
		(1×4)-Oxide	571,706
		Disordered	571
		(2×2)-O	571,706
		c(2×2)-O	571,706,1788
		(3×2)	706
		(1×1)-O	1676,1687
	[clean]	c(2×2)	775,1328
	O ₂	(1×1)-O	349,1328
Mo(110)	[clean]	*(1×1)	1634*
	Al	Hexagonal	515
	Au	Disordered	1681
	C	(4×6)-C	1250
	Cl ₂	(2×1)-Cl	1250
		(1×1)-Cl	1250
		(1×2)-Cl	1250
		(1×3)-Cl	1250
		(1×1)-CO	62,100
		c(2×2)-CO	94
	CO	Disordered	406
		Disordered	94
	CO ₂	Disordered	94
	Cs	Hexagonal	512
	H ₂	Adsorbed	100
	H ₂ S	(2×2)-S	351
		c(2×2)-S	351
		(1×1)-S	351
		c(1×3)-S	351
		c(1×5)-S	351
		(1×3)-S	351
		c(1×7)-S	351
		(1×4)-S	351
		(1×5)-S	351
		c(1×11)-S	351
		$\begin{pmatrix} 2 & 2 \\ -1 & 1 \end{pmatrix}$ -S	351
	K	Hexagonal	512
	KCl	Disordered	781
	N ₂	(1×1)-N	62
	Na	No Ordered Structure	512

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
MoO ₃ (010)	O ₂	(2×2)-O	62,63,100,1154
		(2×1)-O	62,63,100
		(1×1)-O	62,63
		Disordered	350
		Complex	1154
	Rb	Hexagonal	512
	[clean]	(1×1)	922,1128
	H ₂	3D-MoO ₂	922
	Na(110)	[clean]	1754*,1755*
	O ₂	Na ₂ O(111)	352*
Na _{2/3} WO ₃ (110)	[clean]	(3×1)	906
Nb(110)	CO	Disordered	101
		(3×1)-O	101
		(1×1)-H	111
		(3×1)-O	101
		NbO(111)	192
	H ₂	NbO(110)	192
		NbO(220)	192
		Oxide	101
		Complex Pattern	1688
		Disordered	505
Ni(110)	Sn	(3×1)	505
		(2×1)	882
		(1×1)	890,1061!,1459
			1468,1469,1470
			1756*,1757*,1758!,1853!
	C	c(4×5)-C	1198
	Cl ₂	c(2×2)-Cl	1341
		(10×2)-Cl Diffuse	1341
	CO	(1×1)-CO	2,94
		Adsorbed	198
		c(2×1)-CO	353,356,359,645
		(2×1)-CO	356,357,358
		c(2×2)-CO	359,645
	CO+O ₂	(4×2)-CO	359,645
		(3×1)-CO+O ₂	91
	Cs	Disordered	455
	D ₂	(2×1)-D	869,944,1097
		(1×2)-D	869,944,1097
	H ₂	(1×2)-H	59,81,94,110,198
			203,353,360,867
			941,927,1031,1074,1527,1673
		(2×1)-2H	867
		(2×1)-H	941,890,1031,1074
			1527
		c(2×6)-H	890,1031
		(2×6)-H	1074
		(2×3) with streaks	1031
		c(2×4)-H	1031
	H ₂ O	(2×1)-H ₂ O	110
	H ₂ S (or S)	*c(2×2)-S	36,198,205,294
			1079,1142!,1370
			1759*,1853!
		(2×2)-S	1079,1867

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		(3×2)-S	36
		(1×1)-S	1142
	H ₂ Se	c(2×2)-Se	137,1708
	K	Disordered	455
	N ₂	(2×1)-N ₂	1074,1309
		(2/3×1/3)-N ₂	1074
		(2×3)-N	759
		c(2×4)-N ₂	759
	N ₂ ⁺	Disordered	1290
		(2×3)-N	1290
	Na	Disordered	455,458,460
		Hexagonal	455,458,460
	NH ₃	(1×1)-NH ₃	840,880,1560
		(4×2)-NH ₃	840
		c(6×2)-NH ₃	840
		c(4×2)-NH ₃	840,880
		(3×2)-NH	1107
	NH ₃ +e ⁻	c(2×2)-NH ₂	840
		(2×3)-N	840
	NO	(2×3)-N	361
		(2×1)-O	361
	O ₂	(2×1)-O	2,3,51,57,83,89 91,92,99,198,353 354,355,729,912,968 1069,1074,1140 1164,1168,1290 1292,1370,1437 2,51,83,89,91,92 94,198,353,354 355,912,1011,1041 1437 968
		(3×1)-O	2,89
		(2×1)+(3×1)-O	51,354,355,1437
		(5×1)-O	1437
		(9×4)-O	6,51,83,91,198, 354,355
		Disordered	1437
		NiO(100)	1437
		Disordered Oxide	1011
	O ₂ +H ₂ O	(2×1)-OH	1011
	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	471
		(3×1)	471
		(4×1)	471
		(5×1)	471
	Se	c(2×2)-Se	1370
	Te	c(2×2)-Te	1370
	Yb	(2×1)-Yb	844
NiAl(110)	[clean]	*(1×1)	1771*
Ni-25% Fe(110)	H ₂ S, H ₂	(2×3)-S	1121
Ni ₄ Mo(101)	[clean]	Ordered	1115

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Pd(110)	[clean]	*(1×1)	1760*
	Cl ₂	c(16×2)-Cl	1341
	CO	(5×2)-CO	95
		(2×1)-CO	95,209
		(4×2)-CO	209
		c(2×2)-CO	209
		c(4×2)-CO	1359
		(4×1)-CO	1359
		c(4×2)-CO Imperfect	1251
	Cs	*(1×2)+Disordered Cs	1760*
	H ₂	(1×2)-H	212,1173
		(2×1)-H	1173
	H ₂ S	(2×3)	625
		c(2×2)	625
		c(8×2)	625
		(3×2)	625
	Na	*(1×2)+Disordered Na	1760*
	O ₂	(1×3)-O	95
		(1×2)-O	95
		c(2×4)-O	95
	Xe	Hexagonal	743
Pt(110)	[clean]	!(1×2)	960,1062,1080,1166,1187
			1271,1279,1297
			1761!,1890
		(1×1)	1279
	C ₂ N ₂	(1×1)	407,435
	C ₃ O ₂	(1×1)-C ₃ O ₂	365
	Cl ₂	(1×2)-Cl	1341
		(1×1)-Cl	1341
		(2×1)-Cl Diffuse	1341
	CO	(2×1)-CO	366,981,1271
			1279,1297,1360
		(1×1)-CO	139,364,763,1271
			1279,1297,1360
		(1×2)-CO	1360
		(1×1)+(1×2)	1297,1360
		c(8×4)-CO	1271,1279,1360
	CO+NO	(1×1)-CO+NO	364
	H ₂	(1×1)	1279
		(1×2)	1279
	H ₂ S	c(2×6)-S	247,367,368,1114
		(2×3)-S	247,367,368,1114
		(4×3)-S	247,367,368,1114
			1116
		c(2×4)-S	247,367,368,1114
		(4×4)-S	247,367,1114
	HCN	$\begin{pmatrix} 2 \\ 1 & 3 \\ -1 & 2 \\ 3 \end{pmatrix}$	434
		c(2×4)	434
		(1×1)	434

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	HNCO	(2×2)-NCO	657
		(1×2)-NCO	657
	NO	(1×1)-NO	222,364
		(2×1)-NO	614
		c(4×8)-NO	614
		Disordered	614
	O ₂	(2×1)-O	11,363
		(4×2)-O	11
		Adsorbed	362
		c(2×2)-O	363
		PtO(100)	363
		(1×1)-CO	139,364
		(1×3)	763
		(1×5)	763
		(1×7)	763
		Satellite Spots	1279
	Pt-2% Cu(110)	(1×3)	1062
		(1×1)-CO	1063
	Re(10 $\bar{1}$ 0)	*(1×1)	584*
		c(2×2)	1591
	Ba	(1×3)	1675
		(1×1)	977
	Re(11 $\bar{2}$ 0)	*(1×1)	1800*
	Rh(110)	(2×1)-CO	369
		c(2×2)-C	369
	[clean]	Disordered	569
		c(2×2)-S	769
	H ₂ S	Disordered	569,791
	NO	(2×2)-N,O	569,791
		(2×1)-N,O	569,791
	O ₂	Disordered	96,97
		c(2×4)-O	96,97
		c(2×8)-O	96,97
		(2×2)-O	96,97
		(2×3)-O	96,97
		(1×2)-O	96,97
		(1×3)-O	96,97
		c(2×2)-S	769,1473
	S or H ₂ S		
Ru(101)	CO	$\begin{pmatrix} 1 & 1 \\ 3 & 0 \end{pmatrix}$ -CO	372
		$\begin{pmatrix} 0 & 1 \\ 2 & 0 \end{pmatrix}$ -C	372
	NO	Disordered	373
	O ₂	$\begin{pmatrix} 1 & 1 \\ 3 & 0 \end{pmatrix}$ -O	374
		$\begin{pmatrix} 2 & 1 \\ 5 & 0 \end{pmatrix}$ -O	374
		$\begin{pmatrix} 4 & 1 \\ 9 & 0 \end{pmatrix}$ -O	374

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Ru(10 $\bar{1}$ 0)	Cl ₂	(1×1)-Cl	1052
		(2×3)-Cl	1052
		$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$ -Cl	1052
		$\begin{pmatrix} 2 & 0 \\ -1 & 4 \end{pmatrix}$ -Cl	1052
	CO H ₂ N ₂ NO	(2×1)-Cl	1052
		Disordered	371
		Not Adsorbed	371
		Not Adsorbed	371
		c(4×2)-N+O	370,371
		(2×1)-N+O	370,371
		(2×1)-O	371
		c(4×2)-O	371
		c(2×6)-O	370
		(7×1)-O	370
		c(4×8)-O	370
		(2×1)-N	371
		c(4×2)-N	371
		c(4×2)-O	370,371
		(2×1)-O	370,371
		c(2×6)-O	370
		(7×1)-O	370
		c(4×8)-O	370
	O ₂	(2×1)-O	370,371
		c(2×6)-O	370
		(7×1)-O	370
		c(4×8)-O	370
Si(110)	[clean]	(4×5)	803,1685
		(2×1)	803,1685
		(5×1)	803,1685
	Bi	(2×3)-Bi	659
		Disordered	659
	H ₂	(1×1)-H	375
	H ₂ O	Adsorbed	903
	Si,laser	(1×2)	1392
	[clean]	(1×1)	1183
	[clean]	(3×2)	1490
SnO ₂ (101)	[clean]	Hexagonal	508,509
SrTiO ₃ (110)		Square	508,509
Ta(110)	Al	(1×1)-Cl	1180
		(1×2)-Cl	1180
	Cl ₂	c(1×5)-Cl	1180
		c(1×7)-Cl	1180
		Streak <001>	1180
		Complicated	1180
		Disordered	101,102
	CO	(3×1)-O	101,102
		(1×1)-H	102
	H ₂	(1×1)-H	102
		(1×1)-H	102
	I ₂	$\begin{pmatrix} 3 & 0 \\ -1 & 1 \end{pmatrix}$ -I	1180
		(1×1)+c(1×3)-I	1180
		(1×1) with ring	1180
		(1×1) with ring	1180

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
TiO ₂ (100)	N ₂	c(4×4)-I	1180
	O ₂	Not Adsorbed	101
	[clean]	(3×1)-O	101,102
		Oxide	101,102
		(011)-(2×1) facet	1318,1615
		(114)facet	1318
TiO ₂ (110)	H ₂ O	Disordered	376
	O ₂	Disordered	376
	[clean]	(1×1)	1615
	[clean]	*(1×1)	649*,1498,1762*
V(110)	CO	Disordered	101
V ₆ O ₁₃ (001)	O ₂	(3×1)-O	101
	K	(3×1)-O	101
	[clean]	No Superstructure	1186
		(1×1)	1123,1247,1763
	Ag	Hexagonal Structures	546,547
	Au	Ag(111)	1151
		Hexagonal Structures	546,548
		Disordered Hexagonal	533-535
	Ba	Hexagonal	533-535
	Be	$\begin{pmatrix} 2 & 2 \\ 0 & 6 \end{pmatrix}$	533-535
		$\begin{pmatrix} 2 & 2 \\ 0 & 5 \end{pmatrix}$	533-535
		$\begin{pmatrix} 3 & 3 \\ 1 & 5 \end{pmatrix}$	533-535
		Hexagonal Compact	533-535
		(1×9)	529
CO	Cl ₂	(1×1)	529
		$\begin{pmatrix} 9 & 0 \\ -1 & 1 \end{pmatrix}$	529
	CO	(5×2)-Cl	796
		Disordered	109
		c(9×5)-CO	109
		(1×1)-CO	379
		c(2×2)-CO	379
		(2×7)-CO	389
		c(4×1)-CO	389
		(3×1)-CO	389
		(4×1)-CO	389
		(5×1)-CO	389,390
		(2×1)-C+O	389,390
		c(9×5)-C+O	389
	CO+O ₂	c(11×5)-CO+O ₂	93
	Cs	Disordered Hexagonal	523,527,528
	Cu	Hexagonal	523,527,528,1677
		Hexagonal	543-545
		Cu(111)	1151

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Fe	H ₂ or D ₂	3-Dimensional Crystals	451
		Fe(110)	1325
		(1×1)	1325
		(2×1)-H	136,1516,1674
		(1×2)-H	672
		(2×2)-H	1516,1674
		(1×1)-H	1516
		Ordered	1438
		(2×2)-H ₂	1516
		(2×1)-H ₂	1516
I ₂	(2×2)-I	391	
	(2×1)-I	391	
	Li	$\begin{pmatrix} 1 & 5 \\ -2 & 2 \end{pmatrix}$	517-519
(2×2)		517-519	
$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$		517-519	
(2×3)-Li		1269	
c(2×2)-Li		1269	
c(3×1)-Li		1269	
c(1×1)-Li		1269	
(2×2)-N		758	
Na		$\begin{pmatrix} 1 & 5 \\ -2 & 2 \end{pmatrix}$	445,446
		(2×2)	445,446
	$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	445,446	
	$\begin{pmatrix} 1 & 1 \\ 0 & 8 \end{pmatrix}$	445,446	
	$\begin{pmatrix} 1 & 1 \\ 0 & 5 \end{pmatrix}$	445,446	
	Hexagonal	445,446	
	(1×1)-Ni	970	
	(8×2)-Ni	970	
NO	(7×2)-Ni	970	
	(1×1) streaked	661	
	c(11×5)	661,799	
O ₂	(2×2)	661,799	
	(2×1)-O	57,103,377-385,386,387	
		599,699,1277,1418	
		1587,1651	
	c(2×2)-O	104	
	(2×2)-O	104,387,599,699	
	(1×1)-O	104	
	c(14×7)-O	57,103,104,628	
	c(21×7)-O	104	
	c(48×16)-O	104	

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		WO ₃ (100)	388
		WO ₃ (111)	388
	Pd	(1×3)	542
		Hexagonal	542
	Pd(1ML)+CO	Not Adsorbed	1218
	Pd(2.2ML)+O ₂	(2×2)-O	1218
	Pb	Split $\begin{pmatrix} 3 & 0 \\ -1 & 1 \end{pmatrix}$	551,552
		$\begin{pmatrix} 3 & 0 \\ -1 & 1 \end{pmatrix}$	551,552
	S ₂	(2×2)-S	1246
		(7×2)-S	1246
		Rotated Structure	1246
		(1×N)-S (N>=3)	1246
	Sb	$\begin{pmatrix} 1 & 1 \\ 0 & 4 \end{pmatrix}$	553,555
		$\begin{pmatrix} 2 & 0 \\ -1 & 1 \end{pmatrix}$	553,555
		$\begin{pmatrix} 3 & 0 \\ -1 & 1 \end{pmatrix}$	553,555
		$\begin{pmatrix} 4 & 0 \\ -1 & 1 \end{pmatrix}$	553,555
	Sc	$\begin{pmatrix} 1 & 1 \\ 0 & 3 \end{pmatrix}$	536-538
		$\begin{pmatrix} 2 & 2 \\ 0 & 8 \end{pmatrix}$	536-538
	Se	(5×2)-Se	1228
		(1×3)-Se	1228
		Complex	1228
	Sr	$\begin{pmatrix} 3 & 3 \\ -2 & 5 \end{pmatrix}$	530
		$\begin{pmatrix} 2 & 2 \\ 0 & 6 \end{pmatrix}$	530
		$\begin{pmatrix} 2 & 2 \\ 1 & 6 \end{pmatrix}$	530
		$\begin{pmatrix} 1 & 0 \\ 0 & 3 \end{pmatrix}$	530
	Te	Hexagonal	530
		(4×2)-Te	1280
		(20×2)-Te	1280
		(17×2)-Te	1280
		(5×2)-Te	1280
		(22×2)-Te	1280

TABLE II. Surface Structures on Substrates with Two-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	W	Ring Pattern	1623
	WO ₂	(2×2)	1501
	Xe	(2×2)-Xe	713
		Disordered	713
	Y	Hexagonal	539,540
ZnSe(100)	[clean]	($\sqrt{2} \times \sqrt{2}$)R45°	1393
		(5×1)	1393
ZnTe(100)	[clean]	(1×3),(1×1)+{110}f	1393
	Au	(1×1)-Au	1188

[†]Organic overlayer structures are not included. See Table VII for these structures.

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry†

Substrate	Adsorbate	Surface Structure	Reference
Ag(111)	[clean]	*(1×1)	975,1894*,1895*,1896*
	Al	Disordered	491
	Au	*(1×1)	491,1355,1825*
			1826
	Bi	Disordered	491
	Br ₂	($\sqrt{3} \times \sqrt{3}$)R30°-Br	155
		(3×3)-Br	155
	Cd	No Condensation	491
	Cl ₂	(1×1)+Disordered	1050
		($\sqrt{3} \times \sqrt{3}$)R30°-Cl	151,1050
		(10×10)-Cl	151
		AgCl(111)	152,732,1050
	Co	Disordered	491
	CO+O ₂	(2× $\sqrt{3}$)-(CO+O ₂)	27
	Cr	Disordered	491
	Cu	Hexagonal Overlayer	1822-1824
	H ₂ O	Disordered	1034
	H ₂ S	(4×4)-S	627
		$\begin{pmatrix} 3 & 2 \\ -2 & 1 \end{pmatrix}$ -S	627
	I ₂	*($\sqrt{3} \times \sqrt{3}$)R30°-I	145,149,150,1145
			1225*,1259,1440
		Hexagonal Overlayer	1145
	K	Hexagonal Overlayer	1345
	Kr	Hexagonal Overlayer	156
	Mg	Disordered	491
	Na	(1×1)	488
	Ni	Hexagonal Overlayer	491,1821
	NO	Disordered	163
	O ₂	(2×2)-O	1
		($\sqrt{3} \times \sqrt{3}$)R30°-O	1
		Not Adsorbed	146
		(4×4)-O	147,148
	Pb	($\sqrt{3} \times \sqrt{3}$)R30°-Pb	975
		Pb(111)	975
		Hexagonal Overlayer	491,1827
	Pd	(1×1)	1463
		Disordered	491
	Rb	(1×1)-Rb	490,705
		(9×9)	705
	S ₂	($\sqrt{39} \times \sqrt{39}$)R16.1°-S	714
		($\sqrt{7} \times \sqrt{7}$)R10.9° of γ -Ag ₂ S(111)	714
	Sb	Disordered	491
	Sn	Disordered	491
	Tl	Hexagonal Overlayer	491
	Xe	Hexagonal Overlayer	156,157,158,159
			160
		Incommensurate	1599,1845*
	Zn	No Condensation	491

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Ag(111)-Rb dosed	O ₂	(2√3×2√3)R30°-Rb/O	653
		(4×4)-Rb/O	653
Al(111)	[clean]	Complex Structures	653
		(9×9)-Rb/O	653
	Ag	*(1×1)	863,951,1141*,1354,1467*
			1472*,1498,1640
	Ag	Ag-Al(0001)	1161
	CO	Disordered	1175
	Cu	Not Adsorbed	1273
		(1×1)	863
	H ₂ O	Disordered [Multilayer]	863
		Cu(111) [Multilayer]	863
	Mn	Disordered	1157
	Na	$\begin{pmatrix} 6 & 0 \\ -1 & 2 \end{pmatrix}$	502
		Hexagonal rotated ± 9°	502
	Ni	$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	500
		(2×1)	500
	O ₂	(1×1)	1680
		$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	1839
	Pb	(4×4)-O	123
		(1×1)-O	638,709,756,951,1141
Au(111)	[clean]		1397,1467*,1621
			1637,1774!,1775!
	Pd	Oxide-like	1141
		Hexagonal rotated ± 9°	504
	Sn	Hexagonal Overlayer	1060
		Hexagonal Overlayer	1682
	Tl	(√3×√3)R30°-Pd	1661
		Hexagonal Rotated ± 9°	504
	Ag	Hexagonal Overlayer	1060,1682
		(√3×√3)R30°-Tl	1661
	Ag ₂ Air	(23×1)	861,1146,1558,1889
		(5×1)	1146
	Bi	(1×1)	491,1825
		fcc(111)	1689
	Cl ₂	Ag ₂ O(110)-(2×1)	997
		$\begin{pmatrix} 10 & 10 \\ -10 & 20 \end{pmatrix}$	498
Cu	Cr	(2×2)	924
		(1×1)-Cl	647
	Cu	Hexagonal	493
		(√3×√3)R30°-Cu	861,1558,1582
		(1×1)	1558

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		Extra Lines(RHEED)	1836,1837
	Fe	(1×1)	1828,1830-1832
	O ₂	Oxide	161
		Not Adsorbed	162
		Adsorbed	162
	Pb	Hexagonal Rotated ± 5°	444,495
		(√3×√3)R30°	924
		(1×1)	683
	Pd	(1×1)	1807,1834
	Pt	(1×1)	1835
	Si	(2×2)-AuSi	1622
		(3×3)-AuSi	1622
		Hexagonal Silicide	1622
Be(0001)	[clean]	*(1×1)	911,1900*,1901*
	CO	Disordered	22
	H ₂	Not Adsorbed	22
	N ₂	Not Adsorbed	22
	O ₂	Disordered	22
		BeO(0001)-(1×1)	911
		BeO(0001)-(2×2)	911
Bi(0001)	O ₂	(√3×√3)R30°	576,1065,1288
		(1×1)	576
		Coincidence Lattice	576,1065
		BiO	1288
	O ₂ +K	(√3×√3)R30°+BiO(0001)layer	1288
	Cl ₂	(1×1)-Cl	1242
		(2√3×2√3)R30°-BiCl ₃	1242
		(4×4)	1242
C(111), diamond	[clean]	(2×2)	820
		(2×1)	820
		(1×1)	1551
	H ₂ (or D ₂)	(1×1)-H(or D)	30,1386,1697
	H ₂ S	Not Adsorbed	164
	N ₂	Not Adsorbed	164
	NH ₃	Not Adsorbed	164
	O ₂	Adsorbed	16
		Not Adsorbed	164
	P	(√3×√3)R30°-P	30
C(0001), graphite	[clean]	“(2×2)”	1190
		(1×1)	1373,1439,1846*
	Ar	(√3×√3)R30°-Ar	720,960
		Incommensurate	1882,1903
	Ar+Xe	(√3×√3)R30°-Ar,Xe	1193
	CF ₄	(2×2)-CF ₄	1192,1194
		Close to (2×2)	1404
	CO	(√3×√3)R30°-CO	884
		(2√3×2√3)R30°-CO	889
		(2√3×√3)R30° [Herringbone]	884
		Triangular Incommensurate (2×2)	884

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	H ₂	($\sqrt{3} \times \sqrt{3}$)R30°-H ₂	1283
		(2×2)	1373
		($\sqrt{3} \times \sqrt{3}$)R30°	1373
	K (intercalated)	*Disordered	1847*
	KOH	Disordered	1083
	Kr	($\sqrt{3} \times \sqrt{3}$)R30°-Kr	166,167,174,721
			828,960,1616,1904!
		Incommensurate	1413,1616
		Disordered	1413
	N ₂	($2\sqrt{3} \times 2\sqrt{3}$)R30°-N ₂	889
		($\sqrt{3} \times \sqrt{3}$)R30°	1064,1190,1512
		($\sqrt{3} \times \sqrt{3}$)R30°+(2×1)	1435
		Commensurate	1190,1883
		Incommensurate	1443,1883
	NaOH	1/2 Order Ring	1083
	Ne	Incommensurate	629
		($\sqrt{3} \times \sqrt{3}$)R30° rotated by $\pm 17^\circ$	629,960
		Ordered	1338
	NO	Incommensurate	1602
	O ₂	Triangular	1883
		Centered-Parallelogram-O ₂	1425,1883
		($\sqrt{3} \times \sqrt{3}$)R30°-O ₂	1200
		Physisorbed	1411
	Xe	($\sqrt{3} \times \sqrt{3}$)R30°-Xe	165,618,960,1038,1201
Cd(0001)	[clean]	(1×1)	1902
CdS(0001)	O ₂	Disordered	25
CdTe(111)	[clean]	(2×2)	1393
CdTe(111)	[clean]	(1×1),(1×1)+{110}f	1393
Co(0001)	[clean]	*(1×1)	1130,1580,1613*
	CO	($\sqrt{3} \times \sqrt{3}$)R30°-CO	168,1130,1362
		($2\sqrt{3} \times 2\sqrt{3}$)R30°-CO	1130,1362
		c(4×2)-CO	1362,1581
		($\sqrt{7}/2 \times \sqrt{7}/2$)R19.10°-CO	1362
		Hexagonal Overlayer	168
		($\sqrt{7}/3 \times \sqrt{7}/3$)R10.9°-CO	1130
	H ₂ O	Disordered	1310
	NO	($\sqrt{39} \times \sqrt{39}$)R16.1°-N,O	788
	O ₂	No Superstructure	1235
Co(111)	[clean]	*(1×1)	1613*
CoO(111)	[clean]	*(1×1)	1769*
Cr(111)	Ag	(8×8)	46
		$\begin{pmatrix} 2 & \\ 3 & 3 \end{pmatrix}$	
	Au	$\begin{pmatrix} -2 & 4 \\ 3 & 3 \end{pmatrix}$	52
		$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	
	Bi		61

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Cu(111)	[clean]	$\begin{pmatrix} 2 & -1 \\ 0 & 2 \end{pmatrix}$	61
		$\begin{pmatrix} 2 & 3 \\ 1 & 2 \end{pmatrix}$	61
		Fe (1×1)	39
		Ni (1×1)	43,44
		O ₂ ($\sqrt{3} \times \sqrt{3}$)R30°-O	169
		Pb (4×4)	55,58
		Sn $\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	54
		(1×1)	1101,1408,1419 1462,1510,1538 1635
		Ag (8×8)	477
		3 Dimensional Crystals	1813,1815-1818
		(1×1)	1526
		Au $\begin{pmatrix} \frac{2}{3} & \frac{2}{3} \\ -\frac{2}{3} & \frac{4}{3} \end{pmatrix}$	479
		(2×2)	479
		3 Dimensional crystals	1815,1819
		Bi $\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	487
		$\begin{pmatrix} 2 & -1 \\ 0 & 2 \end{pmatrix}$	487
		$\begin{pmatrix} 2 & 3 \\ 1 & 2 \end{pmatrix}$	487
		C ₂ N ₂ Disordered	666
		C Disordered	840,1695
		Cl ₂ ($\sqrt{3} \times \sqrt{3}$)R30°-Cl	151,1102
CO		(6 $\sqrt{3} \times 6\sqrt{3}$)R30°-Cl	151
		(12 $\sqrt{3} \times 12\sqrt{3}$)R30°-Cl	151
		(4 $\sqrt{7} \times 4\sqrt{7}$)R19.2°-Cl	151
		Not Adsorbed	26
		($\sqrt{3} \times \sqrt{3}$)R30°	172,173,590,1306
		(1.5×1.5)R18°	590
		(1.39×1.39)	591,592,593
		($\sqrt{7/3} \times \sqrt{7/3}$)R49.1°	172,173
		(3/2×3/2)	173
		(1×1)-Co	1299

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	Cs	*(2×2)-Cs	711,1430*
	Fe	(1×1)	474
	H ₂	Not Adsorbed	7
	H ₂ S	(√3×√3)R30°-S	35
		Adsorbed	35
	HNCO	Disordered	624
	I ₂	!(√3×√3)R30°-I	574,1259,1779!
	Na	(2×2)-Na	1571
	Ni	*(1×1)-Ni	475,476,1466*
			1813
	Ni(CO) ₄ +CO	(1×1)+Disordered	1048
	O ₂	Disordered	7,170,171,1095
			1244
		(7×7)-O	7,8
		(√3×√3)R30°-O	7,8,1286
		(2×2)-O	7,8,115
		(3×3)-O	8
		(11×5)R5°-O	9
		(2×2)R30°-O	115,119
		$\begin{pmatrix} 3 & 2 \\ -1 & 2 \end{pmatrix}$ -O	1066
		Hexagonal	246
	O ₂ +HCN	Disordered	1244
	O(a)+CO	Disordered	1066
	Pb	(4×4)	481,484
	Pd	(1×1)	726,1144,1538
	Sn	$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	480
	Te	!(2√3×√3)R30°	1905!
	Xe	(√3×√3)R30°-Xe	159
Cu/Al(111)	[clean]	(1×1)	813
		(√3×√3)R30°	813
Cu-5.7% Al(111)	[clean]	(1×1)	813
Cu-10% Al(111)	[clean]	(1×1)	1303
		(√3×√3)R30°-Al	1303
Cu-11% Al(111)	[clean]	(1×1)	1506
Cu-12.5% Al(111)	[clean]	(√3×√3)R30°	813
Cu-16% Al(111)	[clean]	*(√3×√3)R30°	1699*
Cu/Au(111)	[clean]	(2/3√3×2/3√3)R30°	737
		(2×2)	737
Cu/Ni(111)	CO	Disordered	173,734
Cu/Pd(111)	[clean]	(1×1)	737
Cu-25% Zn(111)	[clean]	(1×1)	1152
	O ₂	Disordered	1152

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Fe(111)	[clean] CO	*(1×1)	1700*,1701*
		Disordered	1004
	CO ₂	(1×1)	687
		(5×5)	687
		(3×3)	687
		(1×1)	687
		(5×5)	687
		(3×3)	687
	H ₂	Adsorbed	177
	H ₂ O	(1×1)	687
		(1×1)-H ₂ O	1588
	K	(3×3)-K	665,1350
	N ₂	c(2×2)-N	1350
		(3×3)-N	1350
	N(a)+K	(3×3)-K,N	1350
	NH ₃	Disordered	176,687
		(3×3)-N	176,687
	O ₂	(5×5)	687
		(√19×√19)R23.4°-N	176
		(√21×√21)R10.9°-N	176,687
		(6×6)-O	175
		(5×5)-O	175
		(4×4)-O	175
		(2√7×2√7)R19.1°-O	175
		(2√3×2√3)R30°-O	175
		(1×1)-S	1577,1655
		(1×1)	1249
Fe-18% Cr-12% Ni(111)	[clean]	(√3×√3)R30°-I	1249
	I ₂	Ordered	1249
	H ₂ O	Ordered	1249
	O ₂	Oxide Not Formed	1249
	I(a)+H ₂ O	Adsorbed	1249
	H ₂ O(a)+I ₂	(2×2)	1118
α-Fe ₂ O ₃ (001)	[clean]	Incommensurate	1118
		(√3×√3)R30°	1118
		(1×1)	1241
FeTi(111)	[clean]	(1×1)	1241
GaAs(111)	[clean]	c(8×2)	1170
	Laser-annealed	(1×1)	1170
		(2×2)	1090,1702
GaAs(111)	[clean]	(1×1)	1090
GaAs(111)	Fe(CO) ₅	Facet{100}	1377
GaAs(111)-As rich	[clean]	(2×2)	1524,1541
		(1×1)	1541
GaAs(111)-Ga rich	[clean]	(√19×√19)R23.4°	1541
		(1×1)	1541
GaP(111)	[clean]	*(2×2)	819,1703*

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Ge(111)	[clean]	(2×8)	804,996,1046,1075
		(2×1)	1046,1075,1086
		(1×1)	1296,1374,1683
		c(2×8)	1075,1296,1374
	laser process	(1×1)	1550
		(1×1)	1492
	Al	(2×1)	1550
	Au	($\sqrt{3} \times \sqrt{3}$)R30°-Au	1223
	Cl ₂ or Cl	(7×7)-Cl	1088
		!(1×1)-Cl	1704!
	H ₂ O	(1×1)-H ₂ O	121,179,1662
	H ₂ S	(2×2)-S	37
		(2×1)-S	178
	H ₂ Se	(2×2)-Se	37
	I ₂ or I	(1×1)-I	19,1088
	In	(n×2 $\sqrt{3}$)-In, n=10-13	802
		(4 $\sqrt{3} \times 4\sqrt{3}$)R30°-In	802
		($\sqrt{31} \times \sqrt{31}$)R(±9°)-In	802
		($\sqrt{61} \times \sqrt{61}$)R(30±4°)-In	802
		(4.3×4.3)-In	802
		(4×4)-In	802
		Disordered	17,18
		(1×1)	19,21
		(1×1)-P	19
		($\sqrt{3} \times \sqrt{3}$)R30°-Pb	1075,1400,1474
	Pb	(1×1)-Pb	1075,1474
		($\sqrt{3} \times \sqrt{3}$)R30°	1589
	S	(3×3)	1589
		(2×8)-Ge ₂ S	1589
		(1×1) with streaks	1029
		(2×8)-Sn	639
		($\sqrt{3} \times \sqrt{3}$)R30°-Sn	639,1049
		(7×7)-Sn	639,1049
		(5×5)-Sn	639,1049
		(3×2 $\sqrt{3}$)-Sn	996
		($\sqrt{91} \times \sqrt{3}$)-Sn	996
		(1×1)-Sn	996
	Te	(2×2)-Te	1088
		!(2×2)	849,852,1906!
InSb(111)	[clean]	a-Sn(111) (1×1) [Multi Layer]	849
InSb($\overline{111}$)	[clean]	(3×3)	849,852
	a-Sn	a-Sn(111) (1×1) [Multi Layer]	849
Ir(111)	[clean]	*(1×1)	1705*
	Au	(1×1)	453
		($\sqrt{3} \times \sqrt{3}$)R30°-CO	124,180,182,183
	CO		185,186
		(2 $\sqrt{3} \times 2\sqrt{3}$)R30°-CO	180,182,183,185
			186
			453
	Cr	Hexagonal	453
	H ₂	Adsorbed	187
	H ₂ O	Not Adsorbed	182
	H ₂ S	*($\sqrt{3} \times \sqrt{3}$)R30°-S	822*

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	NO	(2×2)-NO	188
	O ₂	*(2×2)-O or (2×1)-O	124,180,181,182 183,184,827*
		Ir oxide	181
LaB ₆ (111)	[clean]	(1×1)	775,1328
	O ₂	(1×1)	1328
Mg(0001)	[clean]	(1×1)	1289
	O ₂	(1×1)R30°-MgO(111)	655
		($\sqrt{7} \times \sqrt{7}/2$)R19°	655
		Disordered	1289
		(1×1)	797,1289
		MgO(111)	1671
Mo(111)	[clean]	(1×1)	1203
	H ₂ S	c(4×2)-H ₂ S	191
		MoS ₂ (0001)	191
	KCl	disordered	781
	N ₂ +NH ₃	Disordered	1203
	N ₂ +NH ₃	(433)facet	1203
		c(3×2)-N/Mo(433)	1203
	O ₂	(211) facets	14,189
		(110) facets	189
		(4×2)-O	190
		(4×4)	898
		(1×3)	898
		(112)-(1×2) Facets	898
		(112)-(1×3) Facets	898
		MoO ₂ (100)	898
MoS ₂ (0001)	[clean]	*(1×1)	1706*
	Cs	Amorphous Layer	686,855
MoSe(0001)	[clean]	(1×1)	1035
	H ₂ O	Not Adsorbed	1035
	HClO ₄	Not Adsorbed	1035
	I ₂	Slightly Adsorbed	1035
	NaI ₃	Slightly Adsorbed	1035
Na(0001)	[clean]	*(1×1)	1731*
Na ₂ O(111)	[clean]	*(1×1)	1755*
Nb(111)	O ₂	(2×2)-O	192
		(1×1)-O	192
NbSe ₂ (0001)	[clean]	*(1×1)	1706*
Ni(111)	[clean]	*(1×1)	1707*,1794!
	Ag	(6×6)	465,466
	Au	(6×6)	467,468,469,470
		(13×13)	467,468,469
	Bi	($\sqrt{3} \times \sqrt{3}$)R30°-Bi	864
		(7×7)-Bi	864
		($\sqrt{7/4} \times \sqrt{7/4}$)R19°-Bi	864
	Cl ₂	($\sqrt{3} \times \sqrt{3}$)R30°-Cl	206
		$\begin{pmatrix} 2 & 1 \\ 4 & 7 \end{pmatrix}$ -Cl	206
	CO	!($\sqrt{3} \times \sqrt{3}$)R30°-CO	195,196,199,200,1314 1795!
		Hexagonal Overlayer	200

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		(2×2)-CO	3
		($\sqrt{3} \times \sqrt{3}$)R30°-O	5
		(2× $\sqrt{3}$)-CO	5
		($\sqrt{39} \times \sqrt{39}$)-C	5,27
		!(1×1)-C (graphite)	1907
		Disordered	198,1402
		($\sqrt{7} \times \sqrt{7}$)R19.1°	195,196
		($\sqrt{7}/2 \times \sqrt{7}/2$)R19°-CO	957,1402
		c(4×2)-CO	195,196,957,1402
		c(2×2)-CO	1314
		Complex Pattern	1402
	CO ₂	(2×2)-CO ₂	5
		($\sqrt{3} \times \sqrt{3}$)R30°-O	5
		(2× $\sqrt{3}$)-CO ₂	5
		($\sqrt{39} \times \sqrt{39}$)-C	5,27
	GeH ₄	($\sqrt{3} \times 2\sqrt{3}$)R30°	907
		($\sqrt{3} \times \sqrt{3}$)R30°-Ge	907
		(1×1)-Ge	907
	H ₂	(1×1)-H	3
		(2×2)-(2)H	29,201,202,204
			823*,1585,1666
		(2×1)	1667
		Disordered	203
	H ₂ S or S ₂	*(2×2)-S	36,118,197,198
			205*,294,577,990
		($\sqrt{3} \times \sqrt{3}$)R30°-S	992,1264,1493
		(5×5)-S	36,118,577,1264
		Adsorbed	36
		(5 $\sqrt{3} \times 2$)	606,992
		(8 $\sqrt{3} \times 2$)-S	607,608,609
		Complex	1493
	H ₂ Se	!(2×2)-Se	137,577,1708!
		(4×4)-Se	577
		($\sqrt{3} \times \sqrt{3}$)R30°-Se	137,577
	H ₂ O	($\sqrt{3} \times \sqrt{3}$)R30°	1308
	Mo	(5×5)	447,448
		(4×4)	447,448
		$\begin{pmatrix} 2 & 0 \\ 5 & 10 \end{pmatrix}$	447,448
		$\begin{pmatrix} 1 & 0 \\ 5 & 10 \end{pmatrix}$	447,448
	N ₂	Not Adsorbed	131
	Na	Hexagonal	455,458,460
	NH ₃	(2×2)-NH	778
		(6×2)-N	778
		($\sqrt{7} \times \sqrt{7}$)R19°	811,818
		Disordered	811
		($\sqrt{7}/2 \times \sqrt{7}/2$)R19°	1282
	Ni(CO) ₄ .CO	($\sqrt{7}/2 \times \sqrt{7}/2$)R19°-CO	1150
		c(4×2)-CO	1150

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	NO	c(4×2)-NO	193
		Hexagonal Overlayer	193
		(2×2)-O	193
		(6×2)-N	193
		(1×1)-NO	676
		c(4×2)-NO	676
		Complex	676
		(2×2)-O	676
	O ₂	$\begin{pmatrix} 2 & 1 \\ 4 & 7 \end{pmatrix}$ -Cl	206
		*(2×2)-O	2,3,4,116,193,194
			195,196,197*,198
			577,883,990,1282
			1308,1346,1351
			1652
		!($\sqrt{3} \times \sqrt{3}$)R30°-O	2,5,195,577,1346
			1351,1652,1796!
		($\sqrt{3} \times \sqrt{21}$)-O	116
		NiO(111)	4,6,116,193,194
		NiO	1351
	O(a)+H ₂ O	No New Features	1308
	O(a)+NO	(2×2)	676
	Pb	$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	471,472
		(7×7)	471,864
		(13×13)	471,472
		(3×3)	471,864,1060
		(4×4)-Pb	864,1060
		Hexagonal Rotated ± 3°	472
		($\sqrt{3} \times \sqrt{3}$)R30°-Pb	864,1060
Ni-17% Cu(111)	PF ₃	(2×2)	833
	SiH ₄	(2×2)	907
		($\sqrt{3} \times \sqrt{3}$)R30°-Si	907
	Sn	(2×2)-Si	907
		(2×2)-Sn	1060
		($\sqrt{3} \times \sqrt{3}$)R30°-Sn	1060
	Te	(2 $\sqrt{3} \times 2\sqrt{3}$)R30°-Te	577
		($\sqrt{3} \times \sqrt{3}$)R30°-Te	577
	[clean]	(1×1)	868
	H ₂	(2×2)-H	868
Pd(111)	H ₂ S.H ₂	(3×3)-S	1121
	[clean]	!(1×1)	1908!
	Si	($\sqrt{3} \times \sqrt{3}$)R30°-Si	1185
	[clean]	*(1×1)	1770*
	CO	($\sqrt{3} \times \sqrt{3}$)R30°-CO	1169
		(2 $\sqrt{3} \times 2\sqrt{3}$)R30°-CO	1169
		(3 $\sqrt{3} \times 3\sqrt{3}$)R30°-CO	1169
	[clean]	*(1×1)	1208,1509,1709!
	Au		1710*,1861*
		!(1×1)-Au	1709!,1807

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	Br ₂	($\sqrt{3} \times \sqrt{3}$)R30°-Br Ring pattern	1103,1208,1327 1327
	C	Ring pattern	762
	Cl ₂	($\sqrt{3} \times \sqrt{3}$)R30°-Cl (3×3)-Cl	785 785
	CO	*($\sqrt{3} \times \sqrt{3}$)R30°-CO Hexagonal Overlayer c(4×2)-CO c(4×2) Disordered (1×1)	209,210,691,1042,1861* 209 210 691 1208 1509
	CO ₂	Not Adsorbed	691
	Fe	(1×1)	1546
	H ₂	(1×1)-H	211,212
	H ₂ S	*($\sqrt{3} \times \sqrt{3}$)R30°-S	1710*
	NO	c(4×2)-NO (2×2)-NO	208 208
	O ₂	(2×2)-O ($\sqrt{3} \times \sqrt{3}$)R30°-O (2×2)-PdO (1×1)	207,691,1670 207 207 1509,1670
	O ₂ +CO	($\sqrt{3} \times \sqrt{3}$)R30° (2×1)	691 691
Pd-33% Ag(111)	PF ₃ [clean]	(2×2) (1×1)	833 877
Pd-25% Cu(111)	CO [clean]	(1×1) (1×1)	877 877
Pd ₂ Si(0001)	CO [clean]	(1×1) (3×3) (1×1)	877 1555 1555
Pt(111)	[clean]	*!(1×1)	1226,1556,1614*,1711*,1712* 1799*,1874!
	Ag	Disorderd	1254
	Au	Disorderd	1254
	Br ₂	(3×3)-Br	724
	Cu	(12×12)-Cu (2×2)-Cu	1054 1054
	C ₂ N ₂	Disorderd	1002
	Cl ₂ +Br ₂	c(2×4)-Cl,Br ($\sqrt{3} \times \sqrt{3}$)R30°-Cl,Br (3×3)-Cl,Br ($\sqrt{7} \times \sqrt{7}$)R19.1°	610 610 610 610
	CO	($\sqrt{3} \times \sqrt{3}$)R30°-CO *c(4×2)-2CO	218,696,1205,1452 28,107,120,218 219,696,981,1196 1205,1232,1237 1452,1711*
		Hexagonal Overlayer (2×2)-CO ($\sqrt{2/3} \times \sqrt{2/3}$)R15°-CO Ordered	218 120 1232 1232
	CO+O ₂	($\sqrt{3} \times \sqrt{3}$)R30°(Misfit)	909
	Cu	(1×1)-Cu	842

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		Cu(111) Multilayers	842
		Alloy Formation	842
	F	Streak Pattern	1694
	H ₂	Not Adsorbed	120
		Adsorbed	220,221
		(1×1)-H	1110
	H ₂ +C ₂ N ₂	Disorderd	1002
	H ₂ +O ₂	($\sqrt{3} \times \sqrt{3}$)R30°	11
	H ₂ O	($\sqrt{3} \times \sqrt{3}$)R30°-H ₂ O	223,224,929
		H ₂ O(111)	224
		Not Adsorbed	580
	H ₂ S or S ₂	(2×2)-S	225,226,227,247,933,1114,1248
		($\sqrt{3} \times \sqrt{3}$)R30°-S	225,226,227,247,874,933,1114,1712,1248
		Complex Structure	1114
		$\begin{pmatrix} 4 & -1 \\ -1 & 2 \end{pmatrix}$ -S	225,226
		Hexagonal	227
	HBr	c(3×3)-3Br,HBr	806,1258
		(3×3)	806
	HCl	Disordered	806
	HI	($\sqrt{3} \times \sqrt{3}$)R30°-I	774
		($\sqrt{7} \times \sqrt{7}$)R19.1°-I	580,774
	I ₂	($\sqrt{7} \times \sqrt{7}$)R19.1°-I	580,937,1106,1258
			1391,1556
		(3 $\sqrt{3} \times 9\sqrt{3}$)R30°-I	937
		($\sqrt{3} \times \sqrt{3}$)R30°-I	937,1258,1391
		(3×3)-I	937
	I ₂ (a)+HBr	HBr Not Adsorbed	1258
	I(a)+Cu	(3×3)-I,Cu	1556
		(10×10)-I,Cu	1556
	I(a)+Ag	(3×3)-Ag+I	937,1106,1391
		(5×5)-Ag+I	937
		(12×12)-Ag+I	1106
		(17×17)-Ag+I	937
		(18×18)-Ag+I	1106
		(18×18)+(10×10)-Ag+I	1106
		($\sqrt{7} \times \sqrt{7}$)+(3×3)	1391
		($\sqrt{3} \times \sqrt{3}$)R30°-Ag,I	1391
	K	($\sqrt{3} \times \sqrt{3}$)R30°-K	1071,1238,1337
		$\begin{pmatrix} 1.66 & 0 \\ 0 & 1.66 \end{pmatrix}$ -K	1337
		"Ring" Pattern	1337
	K+CO	Disorderd	1255
	K+O ₂	(4×4)-K,O	1238,1337
		(8×2)	1337
		(10×2)	1337
		K ₂ O	1337
	N	Disordered	228
	NH ₃	Disordered	599
		Adsorbed	626
		Not Adsorbed	580

Substrate	Adsorbate	Surface Structure	Reference
	NO	Disordered (2×2)-NO	222 690,1030,1096
	NO ₂	Disordered (2×2)-O,NO,(NO ₂)	1227 1227
	O ₂	(2×2)-O	10,11,213,214,215 216,217,581,952 1221,1237,1248 1301 1221
		(2×2)-O,(O ₂)	1221
		(√3×√3)R30°-O	214,215,217,708
		(1×1)-O	708,1171
		Not Adsorbed	120
		(4√3×4√3)R30°-O	214,215
		PtO ₂ (0001)	214,215
		(3×15)-O	217
		disordered	581
		(3/2×3/2)R15°-O ₂	1221
	SO ₂	Disordered	1179
	S+O ₂	(2×2)-O	1040
	O ₂	Not Adsorbed	1248
	Xe	(√3×√3)R30°-Xe	846
		Hexagonal	846
PtNi(111)	[clean]	*(1×1)	1909
Pt-22% Ni(111)	[clean]	(1×1)	1162
Pt-50% Ni(111)	[clean]	(1×1)	1162
Pt ₃ Ti(111)	[clean]	(2×2)	935
Re(0001)	Ba	(2×2)	565,566
		Hexagonal	565,566
	CO	Not Adsorbed	24
		(2×2)-CO	23
		Disordered	230,1132
		(√3×4)	1176
		(2×√3)	230
	H ₂	Not Adsorbed	24
		Disordered	664
	H ₂ O	(√3×√3)R30°-H ₂ O	1003
		(2×2)-H ₂ O	1003
	N ₂	Not Adsorbed	24
	O ₂	(2×2)-O	23,24,229,723
		Ordered	1515
		(2×1)-O	972,1654
Re(0001) on Pt(111)	CO	(√3×4)rect	843
		(2×2)	843
	O ₂	(2×1)-O	843
Rh(111)	[clean]	*(1×1)	1648,1713*,1800*
	C	(2√3×2√3)R30°-C	1012
	C ₂ N ₂	Adsorbed	926
	Cl ₂	(√3×√3)R30°-Cl	654
		(4×4)-Cl	654
	CO	*(√3×√3)R30°-CO	231,652*,727,931
		*(2×2)-3CO	12,231,727,931
			1122*
		(√3×7)rect	1844

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Ru(0001)	CO+Na	c(4×2)-CO+Na	1844
	CO+NO	Disordered	1876
	CO ₂	($\sqrt{3} \times \sqrt{3}$)R30°-CO	231
		(2×2)-CO	231
	H ₂	Adsorbed	231
	H ₂ +CO	(2×2)	829
		($\sqrt{3} \times \sqrt{3}$)R30°	829
		(2×2)	829
	H ₂ O	($\sqrt{3} \times \sqrt{3}$)R30°-H ₂ O	583
	H ₂ S or S ₂	c(2×4)-S	875
		($\sqrt{3} \times \sqrt{3}$)R30°-S	1768
	NO	c(4×2)-NO	231
		(2×2)-NO	231
	O ₂	(2×2)-O	12,231
		Disordered	570,583
		(2×2)	570
		(2×1)-O	1692
		(8×8)-Rh ₂ O ₃ (0001)	1692
	[clean]	*(1×1)	914,1127*,1233,1380
	C ₂ N ₂	c(2×2)-CN	1217
		(3×3)-CN	1217
		c(4×8)-CN	1217
		(1×2)	1217
		(1×3)	1217
		(1×1)	1217
		Graphite	1217
	CO	*($\sqrt{3} \times \sqrt{3}$)R30°-CO	12,233,248,716
			825,914,1127*
			1357
		(2×2)-CO	12,248
		(2 $\sqrt{3} \times 2\sqrt{3}$)R30°-CO	716,825
		(5 $\sqrt{3} \times 5\sqrt{3}$)R30°-CO	825
	CO+O ₂	(2×2)	768
	CO ₂	($\sqrt{3} \times \sqrt{3}$)R30°-CO ₂	12
		(2×2)-CO ₂	12
	Cu	Disordered	1679
	H ₂	(1×1)-H	234,870
	H ₂ O	($\sqrt{3} \times \sqrt{3}$)R30° + "halo"	1233,1380
		($\sqrt{3} \times \sqrt{3}$)R30°	835,1380
		($\sqrt{3} \times \sqrt{3}$)R30°-H ₂ O	1082
		"Hexagon"	1233,1380
		(2×2)-O ₂	1233
		Complex	1233
	H ₂ S	(2×2)	740
		($\sqrt{3} \times \sqrt{3}$)R30°	740
		c(4×2)	740
	Na	(3/2×3/2)-Na	1129,1406
		Ring Pattern	1129
		(2×2)-Na	1082,1129
		($\sqrt{3} \times \sqrt{3}$)R30°-Na	1082,1129,1406
		Hexagonal Overlayer	1406
	Na+CO	(2 $\sqrt{3} \times 2\sqrt{3}$)R30°	976
	Na+H ₂ O	(2 $\sqrt{3} \times 2\sqrt{3}$)R30°	1082
		Complex	1082

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Sb(0001)	N ₂	Adsorbed	234
		$(\sqrt{3} \times \sqrt{3})R30^\circ-N_2$	1455
	N ₂ O	(2×2)	832
	NH ₃	(2×2)-NH ₃	234,235,1045
		$(\sqrt{3} \times \sqrt{3})R30^\circ-NH_3$	235
		$(2\sqrt{3} \times 2\sqrt{3})R30^\circ-NH_3$	1045
	NO	(2×2)-NO	598
		$(2\sqrt{3} \times 2\sqrt{3})R30^\circ-NH_3$	1045
		(2×1)-NO	963
	O ₂	(2×2)-O	12,232,248,832
			1233
		(2×1)-O	963,1233
		(1×2)-O	619,631
	O(a)+NO	Disordered	963
	Fe	(1×1)	567
Sc(0001)	Th	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	510,511
	[clean]	*(1×1)	1333*
	[clean]	*(2×1)	847,856,947,954
			956,1019,1028
			1086,1087,1361
			1374,1412*,1427,1428
			1457,1477,1528,1533
			1542,1543,1563
			1646*,1714!
		(7×7)	851,857,921,934,954
			996,1019,1021,1022
			1056,1073
			1158,1170,1206,1207
			1210,1342,1457
			1475,1477,1483,1486
Si(111)			1499,1507,1517
			1525,1529,1533
			1536,1537,1543
			1685
		(1×1)	568,954,1366,1427
			1457,1492,1543
			1544
		$(\sqrt{19} \times \sqrt{19})$	1653
	Laser-annealed	*(1×1)	1170,1492,1517,1716*
		(1×1)+Steps	1446
	Ag	(6×1)-Ag	795,807,948,1158
			1342,1696
		$(\sqrt{7} \times \sqrt{7})R19.1^\circ-Ag$	1696
		*($\sqrt{3} \times \sqrt{3}$)R30°-Ag	807,923,1037,1073
			1108,1158,1206
			1322,1342*,1536
			1650,1696,1910!,1911!
			807,948,1037,1158
			1342*,1536,1696
			1536
		$\sqrt{3}(3 \times 1)$	1022,1206
		(1×1)-Ag	
		!Ag Island	1911!

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	Ag(a)+H	$(\sqrt{3} \times \sqrt{3})R30^\circ$	1536
	Al	$(\sqrt{7} \times \sqrt{7})R19.1^\circ$ -Al (1×1) $(\sqrt{3} \times \sqrt{3})R30^\circ$	816 1563 816,1563
	Au	(5×1)-Au	792,1091,1628
		$(\sqrt{3} \times \sqrt{3})R30^\circ$ -Au	1669 792,1091,1215 1322,1499,1628 1669
		(6×6)-Au	792,1091,1215
		(1×1)-Au	956,1091
		$(\sqrt{3} \times \sqrt{3})R30^\circ$ -Bi	736
	Bi	Bi(0001)-(1×1)	736
	Br	Not Specified	1858!, 1859!
	Cl	(7×7) $(\sqrt{19} \times \sqrt{19})$ -Cl	1088 1088,1385
	Cl ₂	Disordered !(7×7)-Cl !(1×1)-Cl	138 138,236,1715! 138,236,1715!
	Co	(1×1) (1×1)-CoSi ₂ $(\sqrt{7} \times \sqrt{7})$ -2d Silicide (2×2) or (2×1)-2d Silicide	851 851,1414 851 851
	Cr	(1×1) $(\sqrt{3} \times \sqrt{3})R30^\circ$ (7×7)	1500 1500 1500
	Cu	(1×1)-Cu Cu(111) or Cu-Si(111) [Multi Layers] 5×5-Cu (4×1) (4×2) [Multi Layer] Cu(111)- $\sqrt{3} \times \sqrt{3}$ [Multi Layer] Cu(111)-(1×1) [Multi Layer]	841 841 841,857,858 856 856 856 856
	Cu(a)+O ₂	"5×5"	856
	D ₂	(7×7)	1369
	Ga	$(\sqrt{3} \times \sqrt{3})R30^\circ$ -Ga (1×1)-Ga (7×7)-Ge (1×1)-Ge (5×5) (5×5)-Ge (5×5)-SiGe(111) Ordered $(\sqrt{3} \times \sqrt{3})R30^\circ$	1028 1028 1029,1537 1029,1486,1544 1475,1483,1486 1029 934,1010 1507 1544
	H ₂	(1×1)-H (7×7)-H (2×1)	237,1216,1477 237,904,1610 1477
	H ₂ O	(1×1) Adsorbed	1477 903
	I	*(7×7)-I	1088*
	I ₂	(1×1)-I !(7×7)-I	133 1857!

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
In		$(\sqrt{3} \times \sqrt{3})R30^\circ$ -In	1028
		(2×2) -In	1028
		Complicated	1028
		(7×7)	1125
		(8×8) -N	34,586,1229
		Doublet	586
		Diffuse	586
		Si (1×1)	1229
		"Quadruplet"	1229
		(1×1)	798
N	NH ₃	(8×8) -N	238
		(7×7) + "quadruplet"	1479
		(7×7) + (8×8)	1479
Ni		$!(1 \times 1)$ -NiSi ₂	838,1434,1659,1860!
		(1×1) -Ni	850,1366,1434
		Disordered	964
		(1×1) -Ni w.streaks	964
		$(\sqrt{3} \times \sqrt{3})R30^\circ$	964,969
		$(\sqrt{19} \times \sqrt{19})R \pm 23.5^\circ$ -Ni	964,1366
		Si (111) - (7×7)	964
		Disordered	1021
		(8×8) -N	1021
		Complex	1021
NO		Disordered	17,20,21
		(1×1)	847
O ₂		$(6\sqrt{3} \times 6\sqrt{3})$ -P	132,133
		(1×1) -P	132
		$(2\sqrt{3} \times 2\sqrt{3})$ -P	132
		(4×4) -P	133
Pd		Disordered	964,1207
		(5×1)	964
		$(\sqrt{3} \times \sqrt{3})R30^\circ$ -Pd	964,1456,1484
			1487,1496
		(3×1) -Pd	1456
		(1×1) +Streaks	964,1456
PH ₃		$(2\sqrt{3} \times 2\sqrt{3})R30^\circ$ -Pd	964,1456
		Pd ₂ Si (Epitaxial)	1134
		(7×7) -P	239
		(1×1) -P	239
		$(6\sqrt{3} \times 6\sqrt{3})$ -P	239
		$(2\sqrt{3} \times 2\sqrt{3})$ -P	239
		(1×1)	1517
		(1×1)	1392
Si+laser		(1×1) -Sb	1019
		(1×1) -Sn	996
Sb		$(\sqrt{3} \times \sqrt{3})R30^\circ$ -Sn	996
		$(2\sqrt{3} \times 2\sqrt{3})R30^\circ$ -Sn	996
		$(\sqrt{133} \times 4\sqrt{3})$ -Sn	996
		$(3\sqrt{7} \times 3\sqrt{7})R(30 \pm 10.9)^\circ$ -Sn	996
		$(2\sqrt{91} \times 2\sqrt{91})R(30 \pm 3.0)^\circ$ -Sn	996
		$!(7 \times 7)$ -Te	1088,1857!
		(1×1) -Te	1617
		(2×1) -Yb	844,1525
Yb		(3×1) -Yb	844,1525

TABLE III. Surface Structures on Substrates with Three-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		(2×1)+(7×7)	844
		(5×1)-Yb	1525
	Xe	(7×7)	1125
Ti(0001)	[clean]	*(1×1)	1007,1717*
	Cd	*(1×1)	562*,563,564
	CO	(1×1)-CO	18,240
		(2×2)-CO	240
		(√3×√3)R30°-N	241,242
	Cu	Extra Spots	561
	N ₂	*(1×1)-N	241,242*
		(√3×√3)R30°-N	241,242
TiC(111)	O ₂	(1×1)-O	18
Th(111)	[clean]	(1×1)	1631
	CO	Disordered	243
		ThO ₂ (111)	243
	O ₂	Disordered	243
		ThO ₂ (111)	243
UO ₂ (111)	O ₂	(3×3)-O	13
		(2√3×2√3)R30°-O	13
W(111)	Cl ₂	Facet Surface	796
	CO	Disordered	746
		{211} facets	746
	O ₂	Disordered	244,746
		{211} facets	15,746
		(4×4)-O	746
Y(0001)	[clean]	(1×1)	1120
Xe(111)	[clean]	*(1×1)	1912*
Zn(0001)	[clean]	*(1×1)	1267,1870*
	Cu	(1×1)	449,450
	O ₂	(1×1)-O	122
		ZnO(0001)	245
	SO ₂	No LEED Pattern	1569
		Oxide	1569
Zn(0001)	O ₂	(√3×√3)R30°-O	122
ZnO(0001)	[clean]	*(1×1)	1104,1239,1773*
	H ₂ O	Disordered	1104
ZnO(0001)	[clean]	(1×1)	1104
	H ₂ O	Disordered	1104
	K	(2√3×2√3)R30°-K	1629
	Xe	Disordered	1026
ZnSe(111)	[clean]	(2×2)	1393
		(1×1)+{110}facet+(2×2)	1393
ZnSe(111)	[clean]	(1×1)	1393
		(1×1)+{331}f+{110}f,{110}f	1393
ZnTe(111)	[clean]	(2×2)	1393
		(1×1)	1393
ZnTe(111)	[clean]	(1×1)+{331}f+{110}f	1393
Zr(0001)	[clean]	*(1×1)	1473,1642*
	O ₂	*(2×2)-O	1718*

*Organic overlayer structures are not included. See Table VII for these structures.

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry†

Substrate	Adsorbate	Surface Structure	Reference
Ag(100)	[clean]	*(1×1)	1272,1562,1897*,1898*,1899*
	Au	(1×1)	1806
	Cl ₂	!c(2×2)-Cl	572,605,732,962
			1719!
	Cl ₂ +K	c(2×2)-K/Cl	673
	Cu	Epitaxial	1167
		Cu(100)	1476
		(1×1)	1820
	Fe	(1×1)	1272
	H ₂ O	Disordered	1034
	H ₂ S	(2×2)-S	627
		$\begin{pmatrix} 4 & -1 \\ 1 & 4 \end{pmatrix}$ -S	627
		$\begin{pmatrix} 4 & 4 \\ -4 & 4 \end{pmatrix}$ -S	627
		Partially Disordered	1117
	I ₂	c(2×2)-I	1145
	K+O ₂	$\begin{pmatrix} 1 & 1 \\ -5 & 4 \end{pmatrix}$	658
		Hexagonal Overlayer	658
	Ni	(1×1)	1820
	O ₂	Disordered	146
	O(ad.)+H ₂ O	c(2×2)-OH	1034
	Pd	Epitaxial	1167
		(1×1)	1463
	Se	*c(2×2)-Se	250*
Al(100)	[clean]	*(1×1)	1077!,1354,1532
			1720*,1721*
	Ag	(5×1)-Ag	1363
		(1×1) [Multilayer]	1363
	Au	Disordered	1363
	CO	Not Adsorbed	1273
		Disordered	1368
	Cu	Disordered	1363
	Fe	Poor Epitaxy	452
	H ₂	(1×1)	1693
	Na	*c(2×2)	499*,500,501,1720*
		Hexagonal Overlayer	500
	O ₂	Disordered	42,43,44,709
	Pb	$\begin{pmatrix} 2 & 0 \\ -1 & 2 \end{pmatrix}$	503
		c(2×2)-Pb	704
		$\begin{pmatrix} 2 & 0 \\ 1 & n \end{pmatrix}$ -Pb	704
		2<n<3	
	Sm	(1×1) Disorder	1532
		Complicated	1532

†Organic overlayer structures are not included. See Table VII for these structures.

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Au(100)	Sn	$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$	503
		c(2×6)-Sn	704
		$\begin{pmatrix} 2 & 0 \\ 1 & n \end{pmatrix}$ -Sn, 2 < n < 3	704
		(1×5)	1153
		c(26×68)	1153
	[clean]	(5×20)	1170,1361
		$\begin{pmatrix} X & 0 \\ Z & Y \end{pmatrix}$	967
		X=24±3, Y=43 or 48, -5≤Z≤0	
		*(1×1)	1170,1293,1361
			1722*
	Ag	(1×1)	473,474,494,1838
	Bi	$\begin{pmatrix} 2 & 0 \\ -1 & 2 \end{pmatrix}$	498
	Br ₂	(1×1)-Br	793
		c(2×2)-Br	793
		(√2×4√2)R45°	793
		c(4×2)	793
	CO	Disordered	252
	Cu	(1×1)	473
	Fe	(1×1)	1828-1830
	H ₂ S	(2×2)-S	251
		c(2×2)-S	251
		(6×6)-S	251
		c(4×4)-S	251
	Na	Hexagonal	492
		Ordered	492
	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	441-444
		$\begin{pmatrix} 1 & 1 \\ -3 & 4 \end{pmatrix}$	441-444
		$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	441-444
		$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$	441-444
	Pd	(1×1)	683
		(1×1)	473,1833
		c(2×2)	683
		c(7√2×√2)R45°	683
		c(3√2×√2)R45°	683
		c(6×2)	683
	Pt	(1×1)	438,439,440
	Xe	Disordered	252

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
BaTiO ₃ (100)	[clean]	(2×2)	853,1490
		(3×3)	1490
		(1×1)	853,1490
		Disordered	853
		Not Adsorbed	164
C(100),diamond	O ₂	Not Adsorbed	164
	H ₂ S	Not Adsorbed	164
	N ₂	Not Adsorbed	164
	NH ₃	Not Adsorbed	164
	O ₂	Disordered	16
CaO(100)	[clean]	Not Adsorbed	164
		(1×1)	755,1641*
Ce(100)	[clean]	$\begin{pmatrix} \frac{3}{5} & \pm \frac{1}{5} \\ \frac{1}{5} & \pm \frac{2}{5} \end{pmatrix}$	845
Co(100)	[clean]	*(1×1)	1539,1776*
	C	(2×2)-C	1539
	CO	c(2×2)-CO	253,1553
		(2×2)-C	253
	H ₂ S or S	(2×2)-S	1539
		c(2×2)-S	1539,1548,1698
	H ₂ S+C	(2×2)-S,C	1539
	O ₂	(2×2)-O	254
		c(2×2)-O	254,1777
	S	*c(2×2)-S	1698*
CoO(100)	[clean]	*(1×1)	1778*
Cr(100)	[clean]	(1×1)	1126,1330,1606
	C,O,N	c(2×2)	1126
	Br ₂	c(2×2)-Br	1051
		c(2×4)-Br	1051
		Pseudohexagonal CrBr ₂	1051
	Cl ₂	c(2×2)-Cl	1330
		(2×5)-Cl	1330
		c(2×4)-Cl	1330
	H ₂ S	c(2×2)-S	1245
	N	(1×1)-N	1330
		(√2R45° × √5R27°)-N	1330
		c(2×2)-N	1330
	N ₂	c(2×2)-N	1245
		c(√2 × 3√2)R ± 45°-N	1245
		(1×1)-N	1245
	O ₂	c(2×2)-O	255,634,1245
		Cr ₂ O ₃ (310)	256
		(1×1)-O	1245
		c(2×4)-O	1245
	Br ₂	c(2×2)-Br	1051
		c(2×4)-Br	1051
		CrBr ₂	1051
Cu(100)	[clean]	*(1×1)	585,1101,1419
			1723*
	Ag	$\begin{pmatrix} 2 & 0 \\ -1 & 5 \end{pmatrix}$	473,477

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	Au	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	473,478
		$\begin{pmatrix} 2 & 0 \\ -1 & 7 \end{pmatrix}$	473,478
Bi		(2×2)	483,486
		$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	483,486
		$\begin{pmatrix} 1 & 1 \\ -4 & 5 \end{pmatrix}$	483,486
		$\begin{pmatrix} 5 & 4 \\ -4 & 5 \end{pmatrix}$	483,486
Cl ₂		(1×1)	703
		c(2×2)	703
Co		*c(2×2)-Cl	1081,1102,1461
			1545,1724*,1869!
Co (Multilayer)+CO	CO	(1×1)-Co	983,1105,1810
		c(2×2)-CO	1811
		*c(2×2)-CO	983
			125,126,265,1005
			1353,1407,1605
			1663,1780*
		(7√2×√2)R45°-CO	1407
		(√2×√2)R45°	1626
Cs		Hexagonal Overlayer	126,127,265
		(2×2)-C	26,125
Cs		Disordered	865
		Hexagonal Overlayer	865
Fe		Quasi-Hexagonal	865
		(1×1)	452,1808,1809
H ₂ S		Adsorbed	35
		!(2×2)-S	35,260,262,1211
			1725!
		(2×1)-S	128
I ₂		Partially Disordered	1117
		!(2×2)-I	1779!
K		$\begin{pmatrix} 2 & 3 \\ 0 & 5 \end{pmatrix}$	1405
		$\begin{pmatrix} 2 & 2 \\ 0 & 3 \end{pmatrix}$	1405
Mn	N ₂	Incommensurate	1405
		c(2×2)-Mn	1319
		(1×1)-N	49
		c(2×2)-N	47,132,258,261
Nb	Ni		266
		Incommensurate	667
		(1×1)	1812

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	O ₂	(1×1)-O (2×1)-O (2×4)R45°-O (2×3)-O c(4×4)-O *!(2×2)-O	9,45 9,45,46 7,47,246,261 119 119 171,246,257,258 259,260,263,264 1417,1726!,1727! 1781*
		(2×2) (2×2√2)R45° Hexagonal (410) facets (√2×√2)R45°-O	171 259,262,263,264 259 259 641,1095,1285
		(√2×2√2)R45°-O (2√2×2√2)R45°-O (√2×0.46nm)R45°-O [Coincidence]	1598,1633 1095,1781 1633 1691
	Pb	$\begin{pmatrix} 2 & 2 \\ -2 & 2 \end{pmatrix}$ $\begin{pmatrix} 1 & 1 \\ -2 & 3 \end{pmatrix}$ *c(5√2×√2)R45°-Pb *c(2×2)-Pb (2√2×2√2)R45°-Pb	481-485 481-485 703,1295* 1295* 1295
	Sn(θ>1)+Pb Pd	Disordered c(2×1)-Pd (1×1)-Pd c(2×2)-Cu ₃ Pd	1041 726 726,1649 1649
	Sn Te	(2×2) *!(2×2)-Te	480 267*,1119,1728!
	Tl	$\begin{pmatrix} 2 & 2 \\ 2 & -2 \end{pmatrix}$ $\begin{pmatrix} 4 & 0 \\ 2 & 7 \end{pmatrix}$ -Tl $\begin{pmatrix} 4 & 0 \\ 2 & 6 \end{pmatrix}$ -Tl $\begin{pmatrix} 6 & 6 \\ 2 & -2 \end{pmatrix}$	1167,1564 1167,1336,1564 1336,1564 1564
	Xe	c(4×4)-Tl Hexagonal Overlayer Disordered	1336 159 741
Cu-3% Al(100)	O ₂	c(2×2)-O Disordered	1632 1632
Cu-5.7% Al(100)	[clean]	(1×1)	813
Cu-12.5% Al(100)	[clean]	(1×1)	813
Cu ₃ Au(100)	[clean]	c(2×2)	916

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Cu/Au(100)	[clean]	c(2×2)	737
Cu/Pd(100)	[clean]	Streak	737
		c(2×2)	737
CuSn(100)	[clean]	c(2×2)	1481
		(3√2×√2)R45°	1481
		c(3×2)+(2×2)	1481
Cu-25% Zn(100)	[clean]	(1×1)	1152
	O ₂	Disordered	1152
EuO(100)	[clean]	(1×1)	1502
Fe(100)	[clean]	*(1×1)	989,1078,1729*
	Br ₂	c(2×2)	752
		(2 sin α' × 2 sin α')Rα'	752
		α' = 26.57°, 37.49°, 40.5°	
		$\begin{pmatrix} 1 & \frac{1}{\tan\alpha} \\ -1 & \frac{1}{\tan\alpha} \end{pmatrix}$	752
		α = 53.13°, 53.47°, 56.31°	
		(√41/5 × √41/5)R38.7°	752
		c(2×4)	752
	CBr ₄	c(2×2)	757
		(2 sin α' × 2 sin α')Rα'	757
	CCl ₄	(2 sin α' × 2 sin α')Rα'	753
		(√13 × √13)R tan ⁻¹ (2/3)	753
		(6×6)-Cl	753
		$\begin{pmatrix} 1 & \frac{1}{\tan\alpha} \\ -1 & \frac{1}{\tan\alpha} \end{pmatrix}$	753
		c(2×2)	753
	CO	*c(2×2)-CO	275*, 1596
		c(2×2)-C,O-Disordered	783, 893, 1601
		Disordered	783
	Fe ₃ O ₄	(1×1)-like	1189
	H ₂	Adsorbed	177
	H ₂ O	c(2×2)	278
	H ₂ S or S	*c(2×2)-S	276, 277*, 1552, 1630
		Complex	1552
		c(6×2)	1552
	I ₂	c(2×2)-I	751
		(2 sin 40.5° × 2 sin 40.5°)R40.5°-I	751
		(√85 × √85)R40.6°-I	751
	K	Disordered	665
		(2×2)-K	784
		Hexagonal Close Pack	784
	N	c(2×2)-N	893
	NH ₃	Disordered	176
		c(2×2)-N	176, 1224
	O ₂	c(2×2)-O	60, 269, 270, 271
			274, 635, 893, 1596
		(1×1)-O	144, 268, 271, 272
			1596

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		FeO(100)	60,269,270,272
			273,635
		FeO(111)	270,635
		FeO(110)	272
		Disordered	273,276
	Se	c(2×2)-Se	1078
	Si	c(2×2)-Si	985,986
	Te	(2×2)-Te	1204
		c(2×2)-Te	1204
Fe/Cr(100)	O ₂	c(2×2)-O	279,636
		c(4×4)-O	279
		Oxide	280
FeTi(100)	[clean]	(1×1)	1241
	S	c(2×2)-S	1241
Ge(100)	[clean]	(2×1)	1094,1213,1522,1636
			1645,1783!
		(2×2)	1449
		(4×2)	804
	Ag	(1×1)-Ag	1522
	Bi	(1×1)-Bi	1449
	I ₂	(3×3)-I	19
	O ₂	Disordered	17,18
		(1×1)	1094
Ir(100)	[clean]	*(1×1)	866,1199*,1293
			1361,1381
		(5×1)	866,1156,1361
			1381,1785*
	Ba	(2×1)-Ba	1399
	CO	c(2×2)-CO	48
		(2×2)-CO	48
		(1×1)-CO	282
	CO ₂	c(2×2)-CO ₂	48
		(2×2)-CO ₂	48
		(7×20)-CO ₂	48
	Cs	c(4×2)-Cs w.Streak	1395
		Close Packed Layer	1395
		Compressed Layer	1395
		(5×5)-Cs	1395
	H ₂	Adsorbed	281
	K	c(2√2×4√2)R45°	866
		$\begin{pmatrix} 2 & 1 \\ -1 & 2 \end{pmatrix}$	866
		c(4×2)	866
		(3×2)	866
		c(2×2)	866
		$\begin{pmatrix} 5 & 0 \\ 2 & 0 \\ -5 & 5 \\ 4 & 3 \end{pmatrix}$	866
		$\begin{pmatrix} 2 & 0 \\ -1 & 5 \\ & 3 \end{pmatrix}$	866

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		$\begin{pmatrix} \frac{10}{7} & 0 \\ -\frac{5}{7} & \frac{5}{3} \end{pmatrix}$	866
	Kr	(3×5)-Kr	283
		Kr(111)	283
	NO	(1×1)-NO	188
	O ₂	(2×1)-O	48,281
		(5×1)-O	48
	O ₂	(1×1)-O	797
KBr(100)	[clean]	(1×1)	1592
KCl(100)	[clean]	(1×1)	1592
LaB ₆ (001)	[clean]	(1×1)	738,1625
	O ₂	(1×1)	770
MgO(100)	[clean]	*(1×1)	755,908,918,1067*,1139,1284 1574*
	Ag	(1×1)	1559
Mo(100)	[clean]	*(1×1)	761*,1379
	Ag	Ag(100)	513,514
		Ag(110)	513,514
	CO	Disordered	62,693
		(1×1)-CO	62,64,285,286 1379
		c(2×2)-CO	64,285,286
		(4×1)-CO	64
	Cs	(√2×√2)R45°	932
		(2×2)	932
		c(2×2)	932
		Rectangular Centered Mesh	932
		Quasi Hexagonal	932
		Hexagonal Overlayer	932
	Cs(a)+O ₂	c(2×2)+(4×1)	932
		(4×1)	932
		Disordered	932
	O(a)+Cs	c(2×2)-Cs+O	932
		(110) Microfacets	932
		Disordered	932
	Ga	(1×1)-Ga	789
	H ₂	c(4×2)-H	77
		(3×2)-H	780
		(√2×√2)-H	780,814
		(1×1)-H	77
	H ₂ S, S, or S ₂	(1×1)-S	130,1149
		(1×1)-S Diffuse	1174
		(√5×√5)-S	130,288
		c(2×2)-S	130,578,917,998, 1039,1149,1174,1913
		MoS ₂ (100)	288
		(2×1)-S	578,612,917,998,1039,1149,1174
		(√5×√5)R26.6°	578,613

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		$c(4 \times 4)$ -S	578,613,998
		$c(4 \times 2)$ -S	578,917,998,1039,1149 1174
		$\begin{pmatrix} 1 & 1 \\ 2 & -1 \end{pmatrix}$ -S	578,917,998,1039,1174,1149
	H ₂ S+O ₂	$(\sqrt{5} \times \sqrt{5})R26.6^\circ$ -S,O	917
	N ₂	(1×1) -N	62
		* $c(2 \times 2)$ -N	287*
	O ₂	Disordered	61,62
		$c(2 \times 2)$ -O	61,62,63,64,284 660,898
		$(\sqrt{5} \times \sqrt{5})R26^\circ$ -O	61,62,189,190,284 660,898,1155,1379
		(2×2) -O	61,189,190,660 1379
		$c(4 \times 4)$ -O	62,189,284,660 898
		* (2×1) -O	189*,190,660,748 898
		(5×5) -O	748
		(4×1)	898
		(6×1) -O	748
		(6×2) -O	284,660,7484
		(3×1) -O	284,748
		(1×1) -O	284,660,898,1155
		$c(4 \times 4)+(2 \times 1)$ -O	748
		$(2 \times 1)+c(2 \times 2)$	748
		Microfacet	660
		streak (1×1) -O	660
		diffuse (1×1) -O	660
		Facet	748
		$(110),(112)$ Facets	898
		MoO ₂ (110)	898
	O(a)+CO	(2×1) -O	817
	O(a)+CO ₂	(2×1) -O	817
	Si	* (1×1) -Si	1730*
	Sn	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	516
		(1×2)	516
		(1×1) -Sn	789
		$c(2 \times 2)$ -Sn	789
NaCl(100)	Ag	Ag(111)	1678
	Xe	Hexagonal Overlayer	289
Na _{0.47} WO ₃ (100)	[clean]	(3×1)	808
Na _{0.72} WO ₃ (100)	[clean]	(2×1)	808
		$c(2 \times 2)$	808
Na _{0.79} WO ₃ (100)	[clean]	(2×1)	1485
Nb(100)	N ₂	(5×1) -N	290
	O ₂	$c(2 \times 2)$ -O	192,290
		(1×1) -O	192,290
		(3×10) -NbO ₂	290

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Ni(100)	[clean]	*!(1×1)	973,1092,1231 1458,1561,1565,1739!,1864*
	Ba	Disordered	454
	C	*(2×2)-C	640,745*,1231,1673
	C(a)+O ₂	c(2×2)-O	1177
	Cl ₂	(2×2)-Cl	662
		c(2×2)-Cl	662
	Co	(1×1)	1803
	CO	*!c(2×2)-CO	54,55,68,129,198 300,301,302,747* 782,950,981,993 1202,1604*,1605 1789*,1790*,1791!,1795!
		c(2×2)	1281
		(2×2)-CO	69
		c(√2×3√2)R45°-CO	1202
		Hexagonal Overlayer	129,301,302
		(2×2)-C	198
		Disordered	1291
	CO+H ₂	c(3×3)	301
	CO ₂	(2×2)-O+c(2×2)-CO	76
	Cr	(1×1)	463,464
	Cs	(2×2)	454
		Hexagonal	463,464
	Cu	*(1×1)-Cu	1113,1458*,1804
	e beam	(2×2)	1401
	Fe	c(2×2)-Fe	973
		(2×2) (Multilayer)	973
		c(2×2) (Multilayer)	973
		Fe(110) (Multilayer)	452,973
	H ₂	Disordered	198,203,211
		c(2×2)-H	301
		(1×1)-H	1092,1202,1658
		(1×1)-H streaked	663
	H ₂ +CO	c(2×2)-CO,H	1202
		c(√2×2√2)R45°-CO,H	1202
	H ₂ S, S, or S ₂	*(2×2)-S	36,118,197,198 621,622,623 637,979,1329,1508 1732*
		!c(2×2)-S	36,118,197!,198 293,294,303,304 340,621-623 681,979,1121,1329 1482,1725!,1734!,1735!,1736!,1792 1793!,1852!
		(2×1)-S	198
		c(2×2)-H ₂ S	304
		Ni ₃ S ₂ Island	681
	H ₂ S,H ₂	c(2×2)-S	1121
	H ₂ S+Na	*c(2×2)Na+c(2×2)S	1887*
		(2×2)Na+c(2×2)S	1887
		(2×2)Na+(2×2)S	1887

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	H ₂ Se	* (2×2) -Se * $c(2 \times 2)$ -Se	197,198,1732*,1866! 142,197,198,293 294,305,340*,1733!
		(2×1) -Se $c(4 \times 2)$ -Se	198 305
	H ₃ P	Disordered	662
	HCl	$c(2 \times 2)$ -HCl $c(2 \times 2)$ -Cl	1644 1644
	I ₂	$c(2 \times 2)$ -I NiI ₂	1036,1148 1148
		$\begin{pmatrix} 1 - \frac{1}{\tan\theta} & -1 - \frac{1}{\tan\theta} \\ \frac{2}{\tan\theta} & \frac{2}{\tan\theta} \end{pmatrix}, \theta \sim 61^\circ$	1148
		$\begin{pmatrix} 5 & -3 \\ 3 & -5 \end{pmatrix}$	1148
		$\begin{pmatrix} 7 & -5 \\ 3 & \frac{3}{5} \end{pmatrix}$	1148
		(2×4) -I ₂ (4×2)	1148 454
	K	Hexagonal	457,461,462
	N ₂	Not Adsorbed (2×2) -N $c(2 \times 2)$ -N ₂	80,81 772,1578 984,987
	N ₂ H ₂	(2×2) -N	690
	Na	* $c(2 \times 2)$ -Na	452,454-459,1737*,1865*
	NH ₃	$c(2 \times 2)$ -N $c(2 \times 2)$ -Na	1137
	NO	(1×1) * $c(2 \times 2)$ -N+O $c(2 \times 2)$ streaked (2×2) Disordered	767,663,812 767,812* 663 767,812 779
	O ₂	* (2×2) -O * $c(2 \times 2)$ -O	2,49,50,51,198 296-299,310,766 978,1095,1138 1168,1195,1356 1358,1364,1417 1732*,1738!,1743! 2,6,52-57,197*,198 290-299,310,340,640 766,978,1044,1095 1138,1168,1195 1220,1356,1358 1417,1441,1565

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
			1738!,1739!,1740!,1741!, 1742!,1743!,1793!
		(2×1)-O	198
		NiO(100)	6,297,298,299,310
		NiO(111)	298,299
		Disordered	1291
	O(a)+CO	c(2×2)-C,O	1356
	P	($\sqrt{5} \times \sqrt{5}$)R26.7°-P	773,1644
		$\begin{pmatrix} 1 & -1 \\ 2 & 3 \end{pmatrix}$ -P	773
		$\begin{pmatrix} 1 & -1 \\ 2 & 1 \end{pmatrix}$ -P	773
	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	471
		$\begin{pmatrix} 1 & 1 \\ -2 & 3 \end{pmatrix}$	471
	Si	($5\sqrt{2} \times \sqrt{2}$)R45°-Pb	773
		c(2×2)-Si	1644
		($2\sqrt{2} \times \sqrt{2}$)R45°-Si	1644
	Sn	c(2×2)-Sn	773
	SO ₂	c(2×2)-SO ₂	86
		(2×2)-SO ₂	86
	S,C	(1×1)	1561
	Te	*(2×2)-Te	197,198,306,1119
			1732*
		*c(2×2)-Te	197,198,294,305
			340,1119,1231
			1597,1744*
		(2×1)-Te	198
		c(4×2)-Te	305,306
		Partially Ordered	1268
	Xe	*(1×1)	1868*
Ni ₃ Al(001)	[clean]		
NiCu(100) (Ni<50%)	S	c(2×2)-S	905
Ni-24% Fe(100)	O ₂	c(2×2)-O	573
Ni-25% Fe(100)	H ₂ S,H ₂	c(2×2)-S	1121
Ni-41% Fe(100)	[clean]	(1×1)	1263
	O ₂	c(2×2)-O	1263
		Oxide	1263
NiO(100)	[clean]	*(1×1)	755,894,1638*
	Cl ₂	Disordered	309
	H ₂	Adsorbed	307
		Ni(100)	307
		(1×1)	894
		Coincidence	894
		(2×2)	894
	H ₂ S	Ni(100)-c(2×2)-S	308
	S	c(2×2)-S	1185
	SO ₂	Disordered	1583

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Pb(100)	O ₂	PbO(100)	1691
Pd(100)	[clean]	*(1×1)	1797*
	Ag	(1×1)	473,1797*
	Au	(1×1)	473,1806,1807
	C	c(4×2)-C	762
	CO	Disordered	70
		c(4×2)-CO	70
		c(2×2)-CO	210
		(2×4)R45°-CO	71,209,210
		c(2√2×√2)R45°-CO	1276,1294
		(2√2×√2)R45°-2CO	910,1797
		Incommensurate	1276
		Hexagonal Overlayer	209,210
	Cu	(1×1)	862
	Fe	Fe(100) and Fe(110)	452
	H ₂	c(2×2)-H	595,919,1163,1454
		(1×1)-H	919
	H(a)+O ₂	Adsorbed	1163,1454
	H ₂ +O ₂	Disordered	1163
		(2×2)-O,H	1163
	H ₂ S	(2×2)-S	1294
		c(2×2)-S	1294
	Kr	Liquid-like	913
	Ni	(1×1)	1805
	NO	(2×2)	910
	O ₂	(2×2)-O	596,597,891,939
			1163,1334,1454
		c(2×2)-O	596,682,939,1334
		(2×2)+(7×7)-O	682
		(5×5)-O	596,1334
		(√5×√5)R27°	596,1334
		Oxide	1334
		Hexagonal	1334
		Disordered O ₂	1454
	O(a)+CO	Disordered	939
	O(a)+H ₂ O	(2×1)-OH	940
	O(a)+H ₂	Not Adsorbed	1163,1454
		(2×2)	1454
	Xe	Hexagonal Overlayer	311
		Liquid-like	913
		Island	913
Pt(100)	[clean]	(5×20) or "hex"	862,946,1265,1394
		(1×1)	1265,1293,1394
			1745*,1798!
		(1×5)	1265,1394,1171
	Au	$\begin{pmatrix} 14 & 1 \\ -1 & 5 \end{pmatrix}$	671
		(1×1)-Au	671
		(1×5)-Au	671
		(1×7)-Au	671
	C	Ring Pattern	762

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	C ₂ N ₂	(1×1)	433
	CO	c(4×2)-CO	28,72,73,120,314
		(3√2×√2)R45°-CO	316,663,952,1307
		(√2×√5)R45°-CO	28,72,73,316
		(2×4)-CO	72,73
		(1×3)-CO	10
		(1×1)-CO	10
		(1×1)-CO	120,312,314,316
		c(2×2)-CO	663
		Reconstructed hex (or 5×20)	312,316,928,1059
			1252,663
	CO+H ₂	c(2×2)-CO+H ₂	1059
	CO+O ₂	(1×1) Diffuse	72,74
		c(2×2)-CO+(3×1)-O	909
	Cu	(1×1)	928
	F ₂	(1×1)-F	862
	H ₂	Adsorbed	886
		(2×2)-H	312,317
		Not Adsorbed	72,74
		(1×1)-H	312
	H ₂ O	Not Adsorbed	582
	H ₂ O+HBr	c(2√2×√2)R45°-Br,HBr	1258
	H ₂ S or S ₂	(2×2)-S	1258
		c(2×2)-S	225,226,247,320
	HBr	c(2√2×√2)R45°-(Br+HBr)	225,226,247,320,321
	Br,HBr(a)+H ₂ O	Not Adsorbed	806,1258
	Br,HBr(a)+NH ₃	No Affinity	1258
	HCl	(2×2)-(Cl+HCl)	1258
	HI	c(√2×√2)R45°-I	806
		c(2×4)-I	580
		Ring Pattern	774
		c(2√2×n√2)R45°, n≥7	774
		c(2√2×√2)R45°-I	774
	I ₂	c(√2×√2)R45°-I	580
		Incommensurate-I	1390
		c(√2×5√2)R45°-I	1390
		c(√2×2√2)R45°-I	1390
		Hexagonal Overlayer	1390
		c(2×4)	1390
		(√7×√7)R19.1°-I	1390
	I(a)+Ag	(√2×√2)R45°-I,Ag	1390
		(10√2×10√2)R45°-I,Ag	1390
		(√34×√34)R31°-I,Ag	1390
	N	Disordered	228
	NH ₃	Poorly Ordered	1258
	NO	(1×1)-NO	318
		c(4×2)-NO	319
		(5×1)-NO	826
		c(2×4)-NO	826
		(1×1)+c(2×4)	946
	NO ₂	(1×1)-N,NO	881
		(5×20)-NO ₂	881

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Pt ₃ Ti(100) Rh(100)	O ₂	Not Adsorbed	120,312
		Adsorbed	312,315
		(2√2×2√2)R45°-O	215,313
		PtO ₂ (0001)	215
		(5×1)-O	315
		(5×1)+(1×1)-O	708,1171
		(2√2×√2)R45°-O	708
		(2×1)-O	315
		(3×1)-O	928,1014
		Complex	1014
	SO ₂ SO ₂ (a)+NH ₃	(1×1) Diffuse	1258
		(1×1) Diffuse	1258
		c(2×2)	935
	[clean]	*(1×1)	895,1024,1348
	Ag	(2×2)	1800*
		(1×1)-Ag	1147
		Complex [Multilayer]	895
	CO	Hexagonal Overlayer	895
		(4×1)-CO	231
		c(2×2)-CO	58
	CO(a)+D ₂ CO ₂	Compressed (CO)	231,1348
		c(2×2)-CO	1348
		Hexagonal Overlayer	231
	D ₂ D(a)+CO	(1×1)-D	231
		c(2×2)	1348
		Fe(100) and Fe(110)	1348
	Fe H ₂ H ₂ S or S	Adsorbed	452
		c(2×2)-S	231
		*(2×2)-S	1403
	N ₂ O NO	(2×2)	742*,1403,1473
		c(2×2)-NO	801
		Disordered	231
	NO+D ₂ O ₂	Disordered	1024
		(2×2)-O	1025
		c(2×2)-O	231,1403
Si(100)	[clean]	c(2×2)	231
		c(2×2)	801
		c(2×8)-O	58
		(3×1)	1403
		*(2×1)	848,980,1017
			1019,1084 ¹ ,1207
			1222,1428,1451,1477
			1494,1483,1505
			1514,1517,1523
			1535,1547,1549
			1645,1746*
		(2×2)	1579
		c(4×2)	1600
		(2×1)	923
	Ag	Ag(111)	1352
	Au	Au(111)	Si(100)

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	Ge	(2×1)	1483
	H	(1×1)-H	325
		(2×1)-H	325
	H ₂	(1×1)-H	322,323,324
			633,680
			1494
		(1×1)-2H	848,999,1222,1477,1488,1535
		(2×1)-H	237,848,999
			1222,1477,1488,1489
			1494,1535
	H ₂ O	(2×1)	1477
		Adsorbed	903
	I ₂	(3×3)-I	326
	In	(2×1)-In	971
		(4×3)-In	971
		(1×1)-In	971
	K	(2×1)-K	1184
	N	Not Ordered	1230
	NH ₃	(111) facets	238
	Ni	NiSi ₂ (100)	854,1659
	O ₂	(1×1)-O	17,18,20
	Pd	Pd ₂ Si (Not Epitaxial)	1134
		(2×1)	1207
		(111) facets	17,18,20
	PH ₃	(2×1)	1451
	Sb	(1×1)-Sb	1019
	Si	(1×1)	1517
	Si+laser	(2×1)	1392
	Sn	c(4×4)-Sn	959
		(6×2)-S	959
		c(8×4)-Sn	959,971
		(5×1)-Sn	959,971
		(2×1)-Sn	959
		(1×1)-Sn	959
SiC(100)	[clean]	(1×1)	1450
SmB ₆ (001)	[clean]	(2×2)	738
		(3×3)	738
Sn(100)	[clean]	(2×1)	1421,1497,1513
	H ₂	(2×1)	1497,1513
Sr(100)	O ₂	SrO(100)	327
SrTiO ₃ (100)	O ₂	(1×1)	1672
		(2×2)	1672
		(2×1)	1672
	Ga	(3×2)-Ga	800
		(5×2)-Ga	800
		(2×2)-Ga	800
		(8×1)-Ga	800,809
Ta(100)	[clean]	*(1×1)	966,1219*
	Au	Split $\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	506,507
	CO	c(3×1)-O	328

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	CO ₂	c(3×1)-O	328
	H ₂	(1×1)	1219
	I ₂	Amorphous	1180
		c(2×10)	1180
		c(2×2)	1180
	N ₂	Adsorbed	328
	NO	c(3×1)-O	328
	O ₂	(2×8/9)-O	328
		c(3×1)-O	328
		(4×1)-O	328
		(3×3)-O	873
		(1×2)-O	873
		(1×3)-O	873
	Th	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	510,511
	Th(100)	(1×1)	510,511
	CO	Disordered	329
	O ₂	Disordered	329
		ThO ₂	329
	TiC(001)	[clean]	(1×1)
		O ₂	Disordered
	UO ₂ (100)	[clean]	c(2×2)
	V(100)	[clean]	*(1×1)
	Br ₂	(1×1)-Br	1126,1315*,1498
		(5×1)-Br	651
		c(2×2)-Br	1126
		(6×4)-Br	1126
		Ring Pattern	1126
	CO	(5×1)-O	1315
	H ₂	Disordered	65
	O ₂	(1×1)-O	65,651
		(2×2)-O	65
		(5×1)-O	1315
	O	(5×1)	1126
	S	c(2×2)-S	650,1315
		(1×1)-S	650
		(5×1)	650
		(√2×√5)R27°-S	1315
	W(100)	[clean]	*(2×2)
			749,1147,1340
			1347,1388,1396
			1503,1668*
		(2×2)	1340
		*(1×1)	1340,1347,1396
			1471,1656,1763*,1802*
	Ag	(2×1)	546
		$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	546
		(1×1)	546
	Au	(2×1)	546

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		$\begin{pmatrix} 2 & 0 \\ -1 & 2 \end{pmatrix}$	546
		(1×1)	546
	Ba	$\begin{pmatrix} 2 & 0 \\ -8 & 2 \end{pmatrix}$	531,532
		split $\begin{pmatrix} 1 & 1 \\ -2 & 2 \end{pmatrix}$	531,532
		$\begin{pmatrix} 1 & 1 \\ -2 & 2 \end{pmatrix}$	531,532
		$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	531,532
		c(4×2)-Ba	735
		c(2√2×√2)-Ba	735
		c(√6×√2)R45°-Ba	735
		c(2√2×2/3√6)R45°-Ba	735
		(2×12)-Ba	994
		(2×10)-Ba	994
		(3×2)-Ba	994
		(3×2)+c(2×2)	994
		c(2×1.86)	994
		(10×21)-Ba	994
		c(2×2)-Ba	1399
		c(2×k) (1.86 ≤ k ≤ 2√2/3)	994
		Hexagonal	994
	Bi	c(2×2)	1260
		(2×2)	1260
		(1×1)	1260
	Br ₂	c(2×2)	604
		(0.75√2×√2)R45°	604
		c(4×2)	604
		(5×2)	604
		c(6×2)	604
		(7×2)	604
		c(8×2)	604
	C	(5×1)-C	821
	Cl ₂	c(2×2)	643
		c(4×1)	644
		(1×1)	644
		$\begin{pmatrix} -7 & 1 \\ 1 & 1 \end{pmatrix}$ -Cl	733
		$\begin{pmatrix} -5 & 1 \\ 1 & 1 \end{pmatrix}$ -Cl	733
		(3√2×√2)R45°-Cl	733
	CO+N ₂	(4×1)-CO+N ₂	82
	CO	Disordered	75
		c(2×2)-CO	66,75,1465
		c(2×2)-C+O	777

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	CO ₂	Disordered (2×1)-O c(2×2)-CO	338 338 338
	Cs	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$ (2×2) Split (2×2) Hexagonal (2×2)	523,524,525,526 523,524,525,526 523,524 525,526 543
	Cu	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	543
	Ga	(1×1)-Ga	789
	H ₂	c(2×2)-H (√2×√2)-H Incommensurate (√2×√2)-H 1 dim order (2×5)-H (4×1)-H *(1×1)-(2*)H (2×2)-H Incommensurate Disordered	66,78,79,337,411 712,771,1275,1347 1361,1388,1603 1668 834,1032,1511 1032 1032 79 79 411,771,897*,1032,1165 1347,1388,1747* 1361 834,1511 771,834
	H ₂ S	(2×1) c(2×2)-S	821 887
	Hg	(1×1)	549
	K	$\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$	1841
	N ₂	*c(2×2)-N Contracted Domain	68,82,131,776 1099,1465*,1748* 1609
	N ₂ O	(1×1)-N ₂ O (4×1)-N ₂ O	143 143
	Na	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	1840
	NH ₃	Disordered c(2×2)-NH ₂ c(2×2)-N (1×1)-NH ₂	84 84 1099 84
	NO	(2×2)-NO (4×1)-NO (2×2)-O (4×1)-O (2×1)-O	339 339 339 339 339

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	O ₂	*Disordered (4×1)-O	330,1749* 66,330-333,336,821 1058
		(2×2)-O	330-334
		(2×1)-O	66,67,330-336,821,1058
		(3×3)-O	331,333,335
		c(2×2)-O	333
		c(8×2)-O	333
		(3×1)-O	333
		(1×1)-O	333
		(8×1)-O	333
		(4×4)-O	333,335
		(110) facets	333
	O ₂ +H ₂	(√2×√2)+(4×1)-O,H	815
	Pb	Disordered (2×2)	550
		Split $\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	550
		$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	550,551
		$\begin{pmatrix} 1 & 1 \\ -2 & 2 \end{pmatrix}$	550
		Hexagonal (2×2)	550 551
		$\begin{pmatrix} 2 & 0 \\ -1 & 2 \end{pmatrix}$	551
		(1×1)	551,702
		c(4×2)-Pb	702
		c(2×2)-Pb	702
	Pd	(2√2×√2)R45°-Pd	646
		(2×1)-Pd	646
		c(2×2)-Pd	646
	Rb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	522
		(2×2)	522
		Hexagonal	522
	S	(2×2)-S	1324
		(3×3)-S	1324
		(4×2)-S	1324
		(2×1)-S	1324
		(5×5)-S	1324
	Sb	(2×2)	553,554
		$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	553,554
		(1×1)	553,554

TABLE IV. Surface Structures on Substrates with Four-fold Rotational Symmetry (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	Se	(2×1)	1326
		(8×1)	1326
		(6×1)	1326
		(3×1)	1326
		c(2×2)	1326
	Sn	(1×1)-Sn	789
		c(2×2)-Sn	789
	Te	(3×3)-Te	1323
		(2×2)-Te	1323
		Complex	1323
		(2×1)-Te	1323
	Th	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	556-560
		(1×1)	556-560
		$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$	559,560
		Hexagonal	559,560
		$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	522
	Rb	(2×2)	522
		Hexagonal	522
		(1×1)	541,764,789
	Zr	$\begin{pmatrix} 2 & 0 \\ -1 & 2 \end{pmatrix}$	541
		c(2×2)	764,789
WO ₃ (100)	[clean]	split (1×1)	991
		(5×1)	1393
		($\sqrt{2} \times \sqrt{2}$)R45°, (5×1)	1393
Xe(100)	[clean]	*(1×1)	1914*

TABLE V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces

Substrate	Adsorbate	Surface Structure	Reference
Ag(100)	Au	(1×1)	1806
		Epitaxial	1167
	Cu	Cu(100)	1476
		(1×1)	1820
		(1×1)	1272
		(1×1)	1820
	Fe	Epitaxial	1167
	Ni	(1×1)	1463
	Pd	(1×1)	1463
		(1×2)	859,1534
Ag(110)	Cs	(1×3)	859,1534
		(1×2)	1534
	K	(1×3)	1534
		(1×2)	1534
	Li	(1×1)	489
Ag(111)	Na	Disordered	491
	Al	(1×1)	491,1355,1825
	Au		1826
	Bi	Disordered	491
	Cd	No Condensation	491
	Co	Disordered	491
	Cr	Disordered	491
	Cu	Hexagonal Overlayer	1822-1824
	K	Hexagonal Overlayer	1345
	Mg	Disordered	491
	Na	(1×1)	488
	Ni	Hexagonal Overlayer	491,1821
	Pb	($\sqrt{3} \times \sqrt{3}$)R30°-Pb	975
		Pb(111)	975
		Hexagonal Overlayer	491,1827
	Pd	(1×1)	1463
		Disordered	491
	Rb	(1×1)-Rb	490,705
		(9×9)	705
	Sb	Disordered	491
	Sn	Disordered	491
	Tl	Hexagonal Overlayer	491
	Zn	No Condensation	491
Al(100)	Ag	(5×1)-Ag	1363
		(1×1) [Multilayer]	1363
		Disordered	1363
	Au	Disordered	1363
	Cu	Poor Epitaxy	452
	Fe	*c(2×2)	499,500,501*,1926*
		Hexagonal Overlayer	500
	Pb	$\begin{pmatrix} 2 & 0 \\ -1 & 2 \end{pmatrix}$	503
		c(2×2)-Pb	704
		$\begin{pmatrix} 2 & 0 \\ 1 & n \end{pmatrix}$ -Pb 2<n<3	704

TABLE V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Au(100)	Sm	(1×1) Disorder Complicated	1532 1532
	Sn	$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$	503
		c(2×6)-Sn	704
		$\begin{pmatrix} 2 & 0 \\ 1 & n \end{pmatrix} 2 < n < 3$	704
	Ag	(1×1)	473,474,494,1838
	Bi	$\begin{pmatrix} 2 & 0 \\ -1 & 2 \end{pmatrix}$	498
	Cu	(1×1)	473
	Fe	(1×1)	1828-1830
	Na	Hexagonal Ordered	492 492
	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	441-444
		$\begin{pmatrix} 1 & 1 \\ -3 & 4 \end{pmatrix}$	441-444
		$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	441-444
		$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$	441-444
	Pd	(1×1) (1×1) c(2×2) c(7√2×√2)R45° c(3√2×√2)R45° c(6×2)	683 473,1833 683 683 683 683
	Pt	(1×1)	438,439,440
Au(110)	Bi	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	498
		$\begin{pmatrix} 2 & 1 \\ -1 & 1 \end{pmatrix}$	498
	Pb	(2×1)	498
		(1×3)	444,495,683
		(1×1)	444,495,683
		(7×1)	444,495,683
		(7×3)	444,495,683
		(4×4)	444,495,683

TABLE V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Au(111)	Ag	(1×1)	491,1825
		fcc(111)	1689
	Ag,Air	Ag ₂ O(110)-(2×1)	997
	Bi	$\begin{pmatrix} 10 & 10 \\ -10 & 20 \end{pmatrix}$	498
		(2×2)	924
	Cr	Hexagonal	493
	Cu	($\sqrt{3} \times \sqrt{3}$)R30°-Cu	861,1558,1582
		(1×1)	1558
		Extra Lines(RHEED)	1836,1837
	Fe	(1×1)	1828,1830-1832
	Pb	Hexagonal Rotated $\pm 5^\circ$	444,495
		($\sqrt{3} \times \sqrt{3}$)R30°	924
		(1×1)	683
	Pd	(1×1)	1807,1834
Au(311)	Pt	(1×1)	1835
	Pb	(5×3)	496
		(3×3)-Pb	730
		(3×4)-Pb	730
Au(511)	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$	444
		$\begin{pmatrix} 2 & 0 \\ 1 & 3 \end{pmatrix}$	444
	Pd	$\alpha(2 \times 2)$	683
		$\alpha(7\sqrt{2} \times \sqrt{2})R45^\circ$	683
		$\alpha(3\sqrt{2} \times \sqrt{2})R45^\circ$	683
		$\alpha(6 \times 2)$	683
	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	444
		$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$	444
Au(711)	Pd	$\alpha(2 \times 2)$	683
		$\alpha(7\sqrt{2} \times \sqrt{2})R45^\circ$	683
		$\alpha(3\sqrt{2} \times \sqrt{2})R45^\circ$	683
		$\alpha(6 \times 2)$	683
	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	444
		$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$	444
	Pd	$\alpha(2 \times 2)$	683
		$\alpha(7\sqrt{2} \times \sqrt{2})R45^\circ$	683
		$\alpha(3\sqrt{2} \times \sqrt{2})R45^\circ$	683
		$\alpha(6 \times 2)$	683
Au(911)	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	444
		$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$	444
	Pd	$\alpha(2 \times 2)$	683
		$\alpha(7\sqrt{2} \times \sqrt{2})R45^\circ$	683
		$\alpha(3\sqrt{2} \times \sqrt{2})R45^\circ$	683
		$\alpha(6 \times 2)$	683
	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	444
		$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$	444
Au(11,1,1)	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	444

TABLE V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$	444
Au(210)	Pb	(1×1)	497
Au(320)	Pb	(3×3)	496
		(1×1)-Pb	730
Cr(111)	Ag	(8×8)	46
		$\begin{pmatrix} \frac{2}{3} & 3 \\ -\frac{2}{3} & \frac{4}{3} \end{pmatrix}$	52
	Au		
	Bi	$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	61
		$\begin{pmatrix} 2 & -1 \\ 0 & 2 \end{pmatrix}$	61
		$\begin{pmatrix} 2 & 3 \\ 1 & 2 \end{pmatrix}$	61
	Fe	(1×1)	39
	Ni	(1×1)	43,44
	Pb	(4×4)	55,58
	Sn	$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	54
Cu(100)	Ag	$\begin{pmatrix} 2 & 0 \\ -1 & 5 \end{pmatrix}$	473,477
	Au	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	473,478
		$\begin{pmatrix} 2 & 0 \\ -1 & 7 \end{pmatrix}$	473,478
	Bi	(2×2)	483,486
		$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	483,486
		$\begin{pmatrix} 1 & 1 \\ -4 & 5 \end{pmatrix}$	483,486
		$\begin{pmatrix} 5 & 4 \\ -4 & 5 \end{pmatrix}$	483,486
		(1×1)	703
		c(2×2)	703

TABLE V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	Co	(1×1)-Co	983,1105,1810
	Cs	Hexagonal Overlayer	1811
		Quasi-Hexagonal	865
		Disordered	865
	Fe	(1×1)	865
			452,1808,1809
	K	$\begin{pmatrix} 2 & 3 \\ 0 & 5 \end{pmatrix}$	1405
		$\begin{pmatrix} 2 & 2 \\ 0 & 3 \end{pmatrix}$	1405
	Mn	Incommensurate	1405
	Nb	c(2×2)-Mn	1319
	Ni	Incommensurate	667
		(1×1)	1812
	Pb	$\begin{pmatrix} 2 & 2 \\ -2 & 2 \end{pmatrix}$	481-485
		$\begin{pmatrix} 1 & 1 \\ -2 & 3 \end{pmatrix}$	481-485
		c(5√2×√2)R45°-Pb	703,1295
		c(2×2)-Pb	1295
		(2√2×2√2)R45°-Pb	1295
	Pd	c(2×1)-Pd	726
		(1×1)-Pd	726,1649
		c(2×2)-Cu ₃ Pd	1649
	Sn	(2×2)	480
	Te	*!(2×2)-Te	267*,1119,1728!
	Tl	$\begin{pmatrix} 2 & 2 \\ 2 & -2 \end{pmatrix}$	1167,1564
		$\begin{pmatrix} 4 & 0 \\ 2 & 7 \end{pmatrix}$ -Tl	1167,1336,1564
		$\begin{pmatrix} 4 & 0 \\ 2 & 6 \end{pmatrix}$ -Tl	1336,1564
		$\begin{pmatrix} 6 & 6 \\ 2 & -2 \end{pmatrix}$	1564
		c(4×4)-Tl	1336
Cu(110)	Au	$\begin{pmatrix} 1 & 0 \\ -1 & 3 \\ 2 & 2 \end{pmatrix}$	479
		(1×2)	479
		(2×2)	479
	Pb	$\begin{pmatrix} 1 & 1 \\ -1 & 1 \end{pmatrix}$	481,482

TABLE V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Cu(111)	Pd	(5×1)	481,482
		(4×1)	482
		(2×1)-Pd	726
		(1×1)-Pd	726
		(8×8)	477
	Ag	3 Dimensional Crystals	1813,1815-1818
		(1×1)	1526
		$\begin{pmatrix} \frac{2}{3} & \frac{2}{3} \\ -\frac{2}{3} & \frac{4}{3} \end{pmatrix}$	479
	Au	(2×2)	479
		3 Dimensional Crystals	1815,1819
		$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	487
	Bi	$\begin{pmatrix} 2 & -1 \\ 0 & 2 \end{pmatrix}$	487
		$\begin{pmatrix} 2 & 3 \\ 1 & 2 \end{pmatrix}$	487
		Co	1299
	Cs	*(2×2)-Cs	711,1430*
	Fe	(1×1)	474
	Na	(2×2)-Na	1571
	Ni	*(1×1)-Ni	475,476,1466*
	Pb	(4×4)	1813
	Pd	(1×1)	481,484
	Pd	(1×1)	726,1538
	Sn	$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	480
Cu(211)	Pb	(4×1)	484
Cu(311)	Pb	$\begin{pmatrix} 3 & 1 \\ -2 & 1 \end{pmatrix}$	484
Cu(511)	Pb	(4×2)	484
Cu(711)	Pb	(4×1)	482
Fe(100)	K	(4×1)	482,484
		Disordered	665
		(2×2)-K	784
		Hexagonal Close Pack	784
		Hexagonal Array	728
Fe(110)	K	(3×3)-K	665,1350
Fe(111)	K	(2×1)	1550
Ge(111)	Al	($\sqrt{3} \times \sqrt{3}$)R30°-Au	1223
Ir(100)	Au	(2×1)-Ba	1399
	Ba	(2×1)-Ba	1399
	Cs	c(4×2)-Cs w.Streak	1395
		Close Packed Layer	1395

TABLE V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		Compressed Layer	1395
		(5×5)-Cs	1395
	K	c(2√2×4√2)R45°	866
		$\begin{pmatrix} 2 & 1 \\ -1 & 2 \end{pmatrix}$	866
		c(4×2)	866
		(3×2)	866
		c(2×2)	866
		$\begin{pmatrix} \frac{5}{2} & 0 \\ -\frac{5}{4} & \frac{5}{3} \end{pmatrix}$	866
		$\begin{pmatrix} 2 & 0 \\ -1 & \frac{5}{3} \end{pmatrix}$	866
		$\begin{pmatrix} \frac{10}{7} & 0 \\ -\frac{5}{7} & \frac{5}{3} \end{pmatrix}$	866
Ir(111)	Au	(1×1)	453
	Cr	Hexagonal	453
Mo(100)	Ag	Ag(100)	513,514
		Ag(110)	513,514
	Cs	(√2×√2)R45°	932
		(2×2)	932
		c(2×2)	932
		Rectangular Centered Mesh	932
		Quasi Hexagonal	932
		Hexagonal Overlayer	932
	Ga	(1×1)-Ga	789
	Sn	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	516
		(1×2)	516
		(1×1)-Sn	789
		c(2×2)-Sn	789
Mo(110)	Al	Hexagonal	515
	Au	Disordered	1681
	Cs	Hexagonal	512
	K	Hexagonal	512
	Na	No Ordered Structure	512
	Rb	Hexagonal	512
Mo(211)	Ba	(1×5)	1591,1675
		(4×2)	1591
	Cs	c(2×1/J), 0.15 < J < 0.64	1590
		c(2×2)	1590
	La	Linear Chains	1447
		c(2×2)	1447
		c(2×4/3)	1447

TABLE V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Nb(110)	Li	(1×4)-Li	1593
		(1×2)-Li	1593
		(1×1)-Li	1593
	Na	(1×4)-Na	1684
		(1×3)-Na	1684
		(1×2)-Na	1684
		(1×3/2)-Na	1684
	Sr	(1×9)-Sr	1594
		(1×5)-Sr	1594
		(4×2)-Sr	1594
	Sn	Disordered	505
		(3×1)	505
Ni(100)	Ba	Disordered	454
	Co	(1×1)	1803
	Cr	(1×1)	463,464
	Cs	(2×2)	454
		Hexagonal	463,464
	Cu	*(1×1)-Cu	1113,1458*,1804
	Fe	c(2×2)-Fe	973
		Fe(110)	452,973
	K	(4×2)	454
		$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	452,454-459
		c(2×2)-Na	1737,1865*
	Ni(110)	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$
		$\begin{pmatrix} 1 & 1 \\ -2 & 3 \end{pmatrix}$	471
		(5√2×√2)R45°-Pb	773
Sn		c(2×2)-Sn	773
Cs		Disordered	455
K		Disordered	455
Na		Disordered	455,458,460
		Hexagonal	455,458,460
Pb		$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	471
		(3×1)	471
		(4×1)	471
Ni(111)			(5×1)
	Yb	(2×1)-Yb	844
	Ag	(6×6)	465,466
	Au	(6×6)	467,468,469,470
		(13×13)	467,468,469
	Bi	(√3×√3)R30°-Bi	864
		(7×7)-Bi	864
		(√7/4×√7/4)R19°-Bi	864
	Mo	(5×5)	447,448
		(4×4)	447,448

TABLE V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Pd(100)		$\begin{pmatrix} 2 & 0 \\ 5 & 10 \end{pmatrix}$	447,448
		$\begin{pmatrix} 1 & 0 \\ 5 & 10 \end{pmatrix}$	447,448
	Na	Hexagonal	455,458,460
	Pb	$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	471,472
		(7×7)	471,864
		(13×13)	471,472
		(3×3)	471,864,1060
		(4×4)-Pb	864,1060
		Hexagonal Rotated $\pm 3^\circ$	472
		($\sqrt{3} \times \sqrt{3}$)R30°-Pb	864,1060
	Sn	(2×2)-Sn	1060
		($\sqrt{3} \times \sqrt{3}$)R30°-Sn	1060
		(2 $\sqrt{3} \times 2\sqrt{3}$)R30°-Te	577
	Te		
	Ag	*(1×1)	473,1797*
	Au	(1×1)	473,1806,1807
	Cs	*(1×2)+Disordered C _s	1760*
	Cu	(1×1)	862
	Fe	Fe(100) and Fe(110)	452
	Na	*(1×2)+Disordered Na	1760*
	Ni	(1×1)	1805
Pd(111)	Au	!(1×1)-Au	1709!
	Fe	(1×1)	1546
Pt(100)	Au	$\begin{pmatrix} 14 & 1 \\ -1 & 5 \end{pmatrix}$	671
		(1×1)-Au	671
Pt(111)	Ag	(1×5)-Au	671
		(1×7)-Au	671
		Disordered	1254
	Au	Disordered	1254
	Cu	(1×1)-Cu	842
		Cu(111) Multilayers	842
		Alloy Formation	842
	K	($\sqrt{3} \times \sqrt{3}$)R30°-K	1071,1238,1337
		$\begin{pmatrix} 1.66 & 0 \\ 0 & 1.66 \end{pmatrix}$ -K	1337
		"Ring" Pattern	1337
Re(0001)	Ba	(2×2)	565,566
		Hexagonal	565,566
Re(10 $\bar{1}0$)	Ba	c(2×2)	1591
	Mg	(1×3)	1675

TABLE V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Rh(100)	Ag	(1×1)	895
		Complex	895
Ru(0001)	Fe	Fe(100) and Fe(110)	452
	Cu	Disordered	1679
	Na	(3/2×3/2)-Na	1129,1406
		Ring Pattern	1129
		(2×2)-Na	1082,1129
		(√3×√3)R30°-Na	1082,1129,1406
Sb(0001)	Fe	Hexagonal Overlayer	1406
		(1×1)	567
	Th	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	510,511
Ta(110)	Al	(1×1)	510,511
		Hexagonal	508,509
Ti(0001)	Cd	Square	508,509
		(1×1)	562,563,564
W(100)	Cu	Extra Spots	561
		(2×1)	546
	Au	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	546
		(1×1)	546
		(2×1)	546
		$\begin{pmatrix} 2 & 0 \\ -1 & 2 \end{pmatrix}$	546
		(1×1)	546
		$\begin{pmatrix} 2 & 0 \\ -8 & 2 \end{pmatrix}$	531,532
	Ba	split $\begin{pmatrix} 1 & 1 \\ -2 & 2 \end{pmatrix}$	531,532
		$\begin{pmatrix} 1 & 1 \\ -2 & 2 \end{pmatrix}$	531,532
		$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	531,532
		c(4×2)-Ba	735
		c(2√2×√2)-Ba	735
		c(√6×√2)R45°-Ba	735
		c(2√2×2/3√6)R45°-Ba	735
		(2×12)-Ba	994
		(2×10)-Ba	994

TABLE V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		(3×2)-Ba	994
		(3×2)+c(2×2)	994
		c(2×1.86)	994
		(10×21)-Ba	994
		c(2×2)-Ba	1399
		c(2×K), (1.86 ≤ K ≤ 2√2/3)	994
		Hexagonal	994
	Bi	c(2×2)	1260
		(2×2)	1260
		(1×1)	1260
	Cs	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	523,524,525,526
		(2×2)	523,524,525,526
		Split (2×2)	523,524
		Hexagonal	525,526
	Cu	(2×2)	543
		$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	543
	Ga	(1×1)-Ga	789
	Hg	(1×1)	549
	K	$\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$	1841
	Na	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	1840
	Pb	Disordered (2×2)	550
		Split $\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	550
		$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	550,551
		$\begin{pmatrix} 1 & 1 \\ -2 & 2 \end{pmatrix}$	550
		Hexagonal	550
		(2×2)	551
		$\begin{pmatrix} 2 & 0 \\ -1 & 2 \end{pmatrix}$	551
		(1×1)	551,702
		c(4×2)-Pb	702
		c(2×2)-Pb	702

TABLE V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces (Continued)

Substrate	Adsorbate	Surface Structure	Reference
W(110)	Pd	$(2\sqrt{2} \times \sqrt{2})R45^\circ$ -Pd	646
		(2×1) -Pd	646
		$c(2 \times 2)$ -Pd	646
	Rb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	522
		(2×2)	522
	Sb	Hexagonal	522
		(2×2)	553,554
	Sn	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	553,554
		(1×1)	553,554
		(1×1) -Sn	789
		$c(2 \times 2)$ -Sn	789
	Th	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	556-560
		(1×1)	556-560
		$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$	559,560
		Hexagonal	559,560
		$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	522
	Zr	(2×2)	522
		Hexagonal	522
		(1×1)	541,764,789
	Ag	$\begin{pmatrix} 2 & 0 \\ -1 & 2 \end{pmatrix}$	541
		$c(2 \times 2)$	764,789
		Hexagonal Structures	546,547
		Ag(111)	1151
		Hexagonal Structures	546,548
		Disordered Hexagonal	533-535
		Hexagonal	533-535
		$\begin{pmatrix} 2 & 2 \\ 0 & 6 \end{pmatrix}$	533-535
		$\begin{pmatrix} 2 & 2 \\ 0 & 5 \end{pmatrix}$	533-535
		$\begin{pmatrix} 3 & 3 \\ 1 & 5 \end{pmatrix}$	533-535
	Ba	Hexagonal Compact	533-535
		(1×9)	529
		(1×1)	529
	Be		

TABLE V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		$\begin{pmatrix} 9 & 0 \\ -1 & 1 \end{pmatrix}$	529
	Cs	Disordered Hexagonal	523,527,528
		Hexagonal	523,527,528,1677
	Cu	Hexagonal	543-545
		Cu(111)	1151
	Fe	3-Dimensional Crystals	451
		Fe(110)	1325
		(1×1)	1325
	Li	$\begin{pmatrix} 1 & 5 \\ -2 & 2 \end{pmatrix}$	517-519
		(2×2)	517-519
		$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	517-519
		(2×3)-Li	1269
		c(2×2)-Li	1269
		c(3×1)-Li	1269
		c(1×1)-Li	1269
	Na	$\begin{pmatrix} 1 & 5 \\ -2 & 2 \end{pmatrix}$	445,446
		(2×2)	445,446
		$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	445,446
		$\begin{pmatrix} 1 & 1 \\ 0 & 8 \end{pmatrix}$	445,446
		$\begin{pmatrix} 1 & 1 \\ 0 & 5 \end{pmatrix}$	445,446
		Hexagonal	445,446
	Ni	(1×1)-Ni	970
		(8×2)-Ni	970
		(7×2)-Ni	970
	Pd	(1×3)	542
		Hexagonal	542
	Pb	Split $\begin{pmatrix} 3 & 0 \\ -1 & 1 \end{pmatrix}$	551,552
		$\begin{pmatrix} 3 & 0 \\ -1 & 1 \end{pmatrix}$	551,552
	Sb	$\begin{pmatrix} 1 & 1 \\ 0 & 4 \end{pmatrix}$	553,555
		$\begin{pmatrix} 2 & 0 \\ -1 & 1 \end{pmatrix}$	553,555

TABLE V. Surface Structures of Metallic Monolayers on Metal Crystal Surfaces (Continued)

Substrate	Adsorbate	Surface Structure	Reference
W(211)		$\begin{pmatrix} 3 & 0 \\ -1 & 1 \end{pmatrix}$	553,555
		$\begin{pmatrix} 4 & 0 \\ -1 & 1 \end{pmatrix}$	553,555
		$\begin{pmatrix} 1 & 1 \\ 0 & 3 \end{pmatrix}$	536-538
		$\begin{pmatrix} 2 & 2 \\ 0 & 8 \end{pmatrix}$	536-538
		$\begin{pmatrix} 3 & 3 \\ -2 & 5 \end{pmatrix}$	530
		$\begin{pmatrix} 2 & 2 \\ 0 & 6 \end{pmatrix}$	530
	Sc	$\begin{pmatrix} 2 & 2 \\ 1 & 6 \end{pmatrix}$	530
		$\begin{pmatrix} 1 & 0 \\ 0 & 3 \end{pmatrix}$	530
		Ring Pattern	1623
		Hexagonal	539,540
		(1×1)-Ag	969
		(1×1)-Au	969
	Sr	(1×2)-Au	969
		(1×3)-Au	969
		(1×4)-Au	969
		(4×1)	518,520
		(3×1)	518,520
		(2×1)	518,520
	W	Incoherent	518,520
		(1×1)	518,520
		[clean]	(2×2)
		(1×7)-Mg	1657
		(3×3)-Mg	1657
		(2×1)	521
W(221)	Li	Compressed(2×1)	521
		(2×1)	553
		(1×1)	553
		Compressed(2×1)	521
	Na	(2×1)	521
		(1×1)-Ni	970
		(6×1)-Ni	970
		(1×1)	449,450
Zn(0001)	Cu	(1×1)	449,450

TABLE VI. Surface Structures of Alloys

Substrate	Adsorbate	Surface Structure	Reference
Ag(111)-Rb dosed	O ₂	(2√3×2√3)R30°-Rb/O	653
		(4×4)-Rb/O	653
		Complex Structures	653
		(9×9)-Rb/O	653
Cu-3% Al(100)	O ₂	c(2×2)-O	1632
		Disordered	1632
Cu-5.7% Al(100)	[clean]	(1×1)	813
Cu-12.5% Al(100)	[clean]	(1×1)	813
Cu ₃ Al(100)	[clean]	c(2×2)	916
Cu/Al(111)	[clean]	(1×1)	835
		(√3×√3)R30°	835
Cu-5.7% Al(111)	[clean]	(1×1)	813
Cu-10% Al(111)	[clean]	(1×1)	1303
		(√3×√3)R30°-Al	1303
Cu-11% Al(111)	[clean]	*(1×1)	1506*
Cu-12.5% Al(111)	[clean]	(√3×√3)R30°	813
Cu-16% Al(111)	[clean]	*(√3×√3)R30°	1699*
Cu/Au(100)	[clean]	c(2×2)	737
Cu/Au(110)	[clean]	Streak	737
		(1×2)	737
		Complex Pattern	737
		c(3×1)	737
		c(2×2)	737
		(2/3√3×2/3√3)R30°	737
Cu/Au(111)	[clean]	(2×2)	737
		(2/3√3×2/3√3)R30°	737
Cu(110)-Ni(1°)	O ₂	(2×1)-O	1311
		c(6×2)-O	1311
Cu/Ni(110)	CO	(2×1)-CO	134
		(2×2)-CO	134
		(1×2)-CO	787
		H ₂	787
		H ₂ S	134
		O ₂	134, 872
Cu/Ni(111)	CO	(2×2)-O	872
Cu/Pd(100)	[clean]	Disordered	173, 734
		Streak	737
Cu/Pd(110)	[clean]	c(2×2)	737
		(2×1)	737
Cu/Pd(111)	[clean]	(1×1)	737
Cu/Pd(111)	[clean]	(1×1)	737
CuSn(100)	[clean]	c(2×2)	1481
		(3√2×√2)R45°	1481
Cu-25% Zn(100)	[clean]	c(3×2)+(2×2)	1481
		(1×1)	1152
Cu-25% Zn(110)	[clean]	Disordered	1152
		(1×1)	1152
	O ₂	Disordered	1152

TABLE VI. Surface Structures of Alloys (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Cu-25% Zn(111)	[clean]	(1×1)	1152
	O ₂	Disordered	1152
Fe/Cr(100)	O ₂	c(2×2)-O	279,636
		c(4×4)-O	279
		Oxide	280
Fe/Cr(110)	O ₂	Cr ₂ O ₃ (0001)	280
		Amorphous Oxide	279
Fe-18% Cr-12% Ni(111)	[clean]	(1×1)	1249
	I ₂	($\sqrt{3} \times \sqrt{3}$)R30°-I	1249
	H ₂ O	Ordered	1249
	O ₂	Ordered	1249
	I(a)+H ₂ O	Oxide Not Formed	1249
	H ₂ O(a)+I ₂	Adsorbed	1249
FeTi(100)	[clean]	(1×1)	1241
	S	c(2×2)-S	1241
FeTi(111)	[clean]	(1×1)	1241
Ni ₃ Al(001)	[clean]	*(1×1)	1868*
NiAl(110)	[clean]	*(1×1)	1771*
NiCu(100) (Ni<50%)	S	c(2×2)-S	905
Ni-17% Cu(111)	[clean]	(1×1)	868
	H ₂	(2×2)-H	868
Ni-24% Fe(100)	O ₂	c(2×2)-O	573
Ni-25% Fe(100)	H ₂ S, H ₂	c(2×2)-S	1121
Ni-25% Fe(110)	H ₂ S, H ₂	(2×3)-S	1121
Ni-25% Fe(111)	H ₂ S, H ₂	(3×3)-S	1121
Ni-41% Fe(100)	[clean]	(1×1)	1263
	O ₂	c(2×2)-O	1263
		Oxide	1263
Ni ₄ Mo(211)	[clean]	Ordered	1115
Pd-33% Ag(111)	[clean]	(1×1)	877
	CO	(1×1)	877
Pd-25% Cu(111)	[clean]	(1×1)	877
	CO	(1×1)	877
Pt-2% Cu(110)	[clean]	(1×3)	1062
	CO	(1×1)-CO	1063
Pt-22% Ni(111)	[clean]	(1×1)	1162
Pt-50% Ni(111)	[clean]	(1×1)	1162
Pt ₃ Ti(100)	[clean]	c(2×2)	935
Pt ₃ Ti(111)	[clean]	(2×2)	935

TABLE VII. Surface Structure Formed by Adsorption of Organic Molecules

Substrate	Adsorbate	Surface Structure	Reference
Ag(100)	C ₂ H ₄ Cl ₂	*c(2×2)-Cl	154,249*,1873*
Ag(110)	C ₂ H ₂	Not Adsorbed	812
	C ₂ H ₄	Not Adsorbed	1690
	C ₂ H ₄ +O ₂	(2×1)-O	1001
	C ₂ H ₄ Cl ₂	(2×1)-Cl	154
		c(4×2)-Cl	154
	O(a)+C ₂ H ₂	c(2×6)-acetylide	1335,1398
		(2×2)-acetylide	1335,1398
		(2×3)-acetylide	1335,1398
		(1×1)-C	1335
Ag(111)	CH ₂ Br ₂	(1×1)	594
	CH ₃ I	(√3×√3)R30°-I	594
	CHCl ₃	(1×1)	594
	C ₂ H ₄ CL ₂	(√3×√3)R30°-Cl	153,154
		(3×3)-Cl	153,154
	Acetic Acid	$\begin{pmatrix} 2 & -0.7 \\ 2 & 2.7 \end{pmatrix} + \begin{pmatrix} 2.8 & 1.4 \\ 0 & 2.5 \end{pmatrix}$	587
		Ring Pattern	587
	Propanoic Acid	$\begin{pmatrix} 4 & 2 \\ 0 & 4.3 \end{pmatrix} + \begin{pmatrix} 3.9 & 1.3 \\ 1 & 4.6 \end{pmatrix}$	587
		$\begin{pmatrix} 4 & 2 \\ 0 & 4.3 \end{pmatrix}$	587
Ag[3(111)×(100)]	CH ₂ Br ₂	(1×1)	594
	CH ₃ I	(√3×√3)R30°-I	594
	CHCl ₃	(1×1)	594
Al(100)	C ₂ H ₄	(1×1)	1693
Au(111)	C ₂ H ₄	Not Adsorbed	161
	benzene	Not Adsorbed	161
	cyclohexene	Not Adsorbed	161
	naphthalene	Disordered	161
	n-heptane	Not Adsorbed	161
Au(S)-[6(111)×(100)]	C ₂ H ₄	Not Adsorbed	161
	benzene	Not Adsorbed	161
	cyclohexene	Not Adsorbed	161
	naphthalene	Disordered	161
	n-heptane	Not Adsorbed	161
C(0001), graphite	CH ₄	(√3×√3)R30°	1018
	C ₂ H ₆	(4×√3)-C ₂ H ₆	1191
		(2×2)-C ₂ H ₆	1191
		(10×2√3)-C ₂ H ₆	1191
		(√3×√3)-C ₂ H ₆	1191
Cr(100)	C ₂ H ₄	c(2×2)-C	1245
		(√2×3√2)R±45°-C	1245
Cu(100)	C ₂ H ₄	(2×2)	26
	O(a)+HCOOH	!Disordered-HCO ₂	1921!,1922!
	O(a)+CH ₃ OH	!Disordered-CH ₃ O	1922!
	Cu-phtalocyanine	$\begin{pmatrix} 5 & -2 \\ 2 & 5 \end{pmatrix}$	408

TABLE VII. Surface Structure Formed by Adsorption of Organic Molecules (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Cu(110)	D-tryptophan	(4×4)	409
	Fe-phtalocyanine	$\begin{pmatrix} 5 & -2 \\ 2 & 5 \end{pmatrix}$	408
	glycine	(4×2)	409
		$\begin{pmatrix} 8 & -4 \\ 0.8 & 1.6 \end{pmatrix}$	409
	H-phtalocyanine	$\begin{pmatrix} 5 & -2 \\ 2 & 5 \end{pmatrix}$	408
	L-alanine	$\begin{pmatrix} 2 & 1 \\ 2 & -1 \end{pmatrix}$	409
	L-tryptophan	(4×4)	409
	D-tryptophan	(4×4)	409
	C ₂ H ₄	Ord. 1D	26
	HCOOH	HCO ₂ -Disordered	1849!
	C ₂ H ₄	Not Adsorbed	26
	Cu-phtalocyanine	Adsorbed	408
	D-tryptophan	$\begin{pmatrix} -8 & 1 \\ -2 & 4 \end{pmatrix}$	409
	Fe-phtalocyanine	Adsorbed	408
	glycine	(8×8)	409
Cu(111)	H-phtalocyanine	Adsorbed	408
	L-alanine	(2√13×2√13)R13°40°	409
	L-tryptophan	$\begin{pmatrix} 7 & 1 \\ -2 & 4 \end{pmatrix}$	409
	CH ₄	Not Adsorbed	132
	C ₂ H ₄	Not Adsorbed	132
	CH ₄	Not Adsorbed	132
	C ₂ H ₄	Not Adsorbed	132
	C ₂ H ₄	c(2×2)-C	274,893
	C ₂ H ₂	(2×2)	687
		(2×3)	687
Fe(100)		Coincidence	687
		$\begin{pmatrix} 4 & 0 \\ -1 & 3 \end{pmatrix}$	687
	C ₂ H ₂	(1×1)	687
		(5×5)	687
		(3×3)	687
	C ₂ H ₄	(1×1)	687
		(5×5)	687
		(3×3)	687
	HCOOH	c(2×2)-H+HCOO	1124,1302
	C ₂ H ₂	Disordered	281,410
GaAs(110) Ir(100)		c(2×2)-C	281,410
	C ₂ H ₄	Disordered	410
		c(2×2)-C	410
	benzene	Disordered	410

TABLE VII. Surface Structure Formed by Adsorption of Organic Molecules (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Ir(110)	C ₂ H ₄	Disordered	347
		(1×1)-C	347
	benzene	Disordered	347
		(1×1)-C	347
Ir(111)	C ₂ H ₂	(√3×√3)R30°	187
		(9×9)-C	187
	C ₂ H ₄	(√3×√3)R30°	187
		(9×9)-C	187
	benzene	(3×3)	187
		(9×9)-C	187
	cyclohexane	Disordered	187
Ir(S)-[6(111)×(100)]		(9×9)-C	187
	C ₂ H ₂	(2×2)	187
	C ₂ H ₄	(2×2)	187
	benzene	Disordered	187
	cyclohexane	(2×2)	187
Mo(100)	CH ₄	c(4×4)-C	286
		c(2×2)-C	286
		c(6√2×2√2)R45°-C	286
		(1×1)-C	286
	C ₂ H ₄	c(2×2)-carbide	602,603,659
		$\begin{pmatrix} 3 & 0 \\ 1 & -1 \end{pmatrix}$	602,603,660
		(1×1)	602,603,660
		(1×1) w. Streaks	1379
		c(2×2)-C	660
	HCOOH	Disordered	1155
	O(a)+C ₂ H ₄	(2×1)-O	817
	O(a)+HCOOH	(2×1)-O,C	1155
Ni(100)	CH ₄	c(2×2)	117
		(2×2)	117
	C ₂ H ₂	*c(2×2)	416,1923*
		(2×2)	416
		c(4×2)	417
		(2×2)-C	417
	C ₂ H ₄	c(2×2)	88,416
		Quasi-c(2×2)	1561
		(2×2)	416
		(2×2)-C(p4g)	417,670,745, 1092,1177
		c(4×2)	417
		(√7×√7)R19°-C	88
	C ₂ H ₆	c(2×2)	117
		(2×2)	117
	CH ₃ OH	Disordered	601
		c(2×2)	601
	benzene	c(4×4)	415
Ni(110)	CH ₄	(2×2)	117
		(4×3)	117
		(4×5)-C	117,418
		(2×3)-C	418,679

TABLE VII. Surface Structure Formed by Adsorption of Organic Molecules (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Ni(111)	C_2H_2 C_2H_4	$c(2 \times 2)-C_2H_2$	915
		$(2 \times 1)-C$	419,420,421
	C_2H_6 CH_3OH	$(4 \times 5)-C$	419,420,915
		" $c(2 \times 4)$ "- C_2H_4	915
		$c(2 \times 2)-CCH$	915
		Graphite Overlayer	420
		(2×2)	117
	C_5H_{12}	$c(2 \times 4)-CH_3O$	890
		$c(2 \times 6)-CH_3O$	890
		$c(2 \times 2)-CO$	890
		(4×3)	422
	CH_4	(4×5)	422
		(2×2)	117
		$(2 \times 2)-C$	990
		Graphite	990
		$(2 \times \sqrt{3})$	117
		$(16\sqrt{3} \times 16\sqrt{3})-R30^\circ-C$	739
		(4×5)	739
		$^*(2 \times 2)-C_2H_2$	412,413,719,1262*,1925!
	C_2H_2	$(\sqrt{3} \times \sqrt{3})R30^\circ+(2 \times 2)$	719
		Disordered	1627
	C_2H_4 C_2H_6	(2×2)	29,39,412
		(2×2)	39,117
	benzene cyclohexane $HCOOH$	$(2 \times \sqrt{3})$	117
		$(\sqrt{7} \times \sqrt{7})R19^\circ-C$	29
		$(2 \times 2)-C$	990
		Disordered Graphite	990
		$(2\sqrt{3} \times 2\sqrt{3})R30^\circ$	414,415
		$(2\sqrt{3} \times 2\sqrt{3})R30^\circ$	414
		Not Adsorbed	1691
		$c(4 \times 4)$	616,617
		$(2 \times 2)R45^\circ-C_6H_6$	616,617,630
		$(\sqrt{3} \times \sqrt{3})R30^\circ-C_2H_2$	1043,1209
Pd(100)	C_2H_2 C_2H_4	$(\sqrt{3} \times \sqrt{3})R30^\circ$ Diffuse	1209
		Disordered	1266
	CH_3OH	$(\sqrt{3} \times \sqrt{3})R30^\circ-C_2H_3$	1266
		$(\sqrt{3} \times \sqrt{3})R30^\circ-CO,H_2$	1042
	Benzene Benzene + CO	Complex	1042
		Disordered	961
		$(2\sqrt{3} \times 2\sqrt{3})R30^\circ$	961
		Complex	961
	C_2H_2 C_2H_4	$^*(3 \times 3)-C_6H_6+2CO$	961,1862*
		$c(2 \times 2)$	28,72,321,431,432
Pt(100)	C_2H_2 C_2H_4	$c(2 \times 2)$	28,72,313,321,431
		Graphite Overlayer	313,426
	acrylic acid acrylic acid(a)+ NH_3	$(511),(311)$ facets	426
		(1×1) Diffuse	1258
	aniline benzene	(1×1) Diffuse	1258
		Disordered	430
	benzene	Disordered	432
		2(1 dimensional order)	429
	cyanobenzene mesitylene	Disordered	430
		3(1 dimensional order)	430

TABLE VII. Surface Structure Formed by Adsorption of Organic Molecules (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Pt(110)	M-xylene	3(1 dimensional order)	430
	naphthalene	(1×1)	429
	nitrobenzene	Disordered	430
	N-butylbenzene	Disordered	430
	pyridine	(1×1)	429
		c(2×2)	429
	toluene	3(1 dimensional order)	430
	T-butylbenzene	Disordered	430
	HCOOH	1-D Disordered	1080
	CH ₃ NCO	(1×2)	938
Pt(111)	benzene	Disordered	1172
	C ₂ H ₂	(2×1)	28
		(2×2)	423,424,425,1316
			1196
	C ₂ H ₂ +H ₂	*(2×2)-C ₂ H ₃	824*,1316,1587
	C ₂ H ₄	(2×2)	40,424,425,1196
			1313
		(2×2)-C ₂ H ₃	824,1316,1586
		(2×1)	28
		2(1 dimensional order)-C	221
		Disordered	1316
		Complex	1313
		Graphite Overlayer	221,426,1093
	(O)+C ₂ H ₄	(2×2)	1313
		Ordered	1313
	C ₃ H ₄	(2×2)	1316
	C ₃ H ₄ +H ₂	(2×2)	1316
	C ₃ H ₆	Disordered	1316
		(2×2)	1316
	cis-2-C ₄ H ₈	(2√3×2√3)R30°	1316
	trans-2-C ₄ H ₈	(8×8)	1316
	C ₁₀ H ₈	(6×3)-C ₁₀ H ₈	668
	acetic acid	(2×2)	580,1287
		Disordered	587,1287
	acetonitrile	(1×1) Diffuse	1258
		(2×2)	580,1287
		Disordered	1287
	acetonitrile+I ₂	I ₂ Adsorbed	1258
	aniline	3(1 dimensional order)	430
	azulene	Disordered	1349
		(3×3)	1349
		(3×3)+(3×3)R30°	1349
		(10×10)	1349
	benzene	Disordered	429,1854,1891
		Graphite	1924
	benzene+CO	$\begin{pmatrix} -2 & 2 \\ 5 & 5 \end{pmatrix} = \begin{pmatrix} 4 & -2 \\ 0 & 4 \end{pmatrix}$	221,428,429
		$* \begin{pmatrix} 4 & -2 \\ 0 & 5 \end{pmatrix} = \begin{pmatrix} -2 & 2 \\ 4 & 4 \end{pmatrix}$	428,429,1854*
		= (2√3×4)rect-2C ₆ H ₆ +4CO	
	cyanobenzene	3(1 dimensional order)	430

TABLE VII. Surface Structure Formed by Adsorption of Organic Molecules (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	cyclohexane	$\begin{pmatrix} 4 & -1 \\ 1 & 5 \end{pmatrix}$	427
		Disordered	221
		(2×2)	221
		Graphite Overlayer	221
	dichloromethane	Not Adsorbed	580
	dimethylsulfoxide	(2×2)	580,1287
		$(\sqrt{3} \times \sqrt{3})R30^\circ$	1287
		(1×1)	1287
	dimethylformamide	(2×2) Diffuse	580,1258
		Disordered	1287
	DMSO	(1×1)-DMSO	1258
	DMSO(a)+I ₂	Ordered	1258
	DMSO(a)+pyridine	Not Adsorbed	1258
	I(a)+pyridine	Not Adsorbed	1258
	I(a)+acetonitrile	Not Adsorbed	1258
	I(a)+DMSO	DMSO Not Adsorbed	1258
	I ₂ +DMSO	$c(2 \times 4\sqrt{3}/3)$ -I ₂ ,DMSO	1258
	mesitylene	3.4(1 dimensional order)	430
	m-xylene	2.6(1 dimensional order)	430
	naphthalene	(6×6)	224,429
		naphthalene (001)	224
		(6×3)	1349
		Disordered	1349
	nitrobenzene	3(1 dimensional order)	430
	n-butane	$\begin{pmatrix} 2 & 1 \\ -1 & 2 \end{pmatrix}$	427
		$\begin{pmatrix} 2 & 2 \\ -5 & 5 \end{pmatrix}$	427
		$\begin{pmatrix} 3 & -2 \\ 2 & 5 \end{pmatrix}$	427
	N-butylbenzene	Disordered	430
	n-heptane	$\begin{pmatrix} 2 & 1 \\ 0 & 8 \end{pmatrix}$	427
		(2×2)	221
	n-hexane	$\begin{pmatrix} 2 & 1 \\ -1 & 3 \end{pmatrix}$	427
	n-octane	$\begin{pmatrix} 2 & 1 \\ -1 & 4 \end{pmatrix}$	427
	n-pentane	$\begin{pmatrix} 2 & 1 \\ 0 & 6 \end{pmatrix}$	427
	propylene-carbonate	(2×2)	580,1287
		Disordered	1287
	propanoic Acid	Disordered	587

TABLE VII. Surface Structure Formed by Adsorption of Organic Molecules (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Pt(S)-[7(111)×(100)]	pyridine	(2×2)	429,580,1287
		(1×1) Diffuse	1258
		Disordered	1287
	pyridine(a)+DMSO	Not Adsorbed	1258
	pyridine(a)+H ₂ O	Not Adsorbed	1258
	pyridine(a)+I ₂	I ₂ Adsorbed	1258
	p-dioxane	(2×2)	580,1287
		Disordered	1287
	sulfolane	(2×2)	580,1287
		($\sqrt{3} \times \sqrt{3}$)R30°	580,1287
		(1×1)	580,1287
	toluene	3(1 dimensional order)	221,430
		(4×2)	430
		Graphite Overlayer	430
	T-butylbenzene	Disordered	430
	azulene	1/3 order ring	1057
	naphthalene	1/3 order spots	1057
Pt(S)-[4(111)×(100)]	C ₂ H ₄	Disordered	221
		Graphite Overlayer	221
		Facets	221
	benzene	Disordered	221
		Graphite Overlayer	221
		Facets	221
	cyclohexane	Disordered	221
		(4×2)-C	221
	n-heptane	(4×2)	221
		(4×2)-C	221
	toluene	Disordered	221
		2(1 dimensional order)-C	221
	C ₂ H ₄	(2×2)	120,221
		$\begin{pmatrix} 3 & 2 \\ -2 & 5 \end{pmatrix}$ -C	221
		$\begin{pmatrix} 6 & 1 \\ -1 & 7 \end{pmatrix}$ -C	221
		($\sqrt{19} \times \sqrt{19}$)R23.4°-C	426
		Graphite Overlayer	426
	benzene	3(1 dimensional order)	221
Pt(S)-[6(111)×(100)]		(9×9)-C	221
	cyclohexane	2(1 dimensional order)	221
	n-heptane	(2×2)	221
		$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	221
		(9×9)-C	221
	toluene	Disordered	221
		(9×9)-C	221
	C ₂ H ₄	Disordered	221
		Graphite Overlayer	221
	benzene	Disordered	221
	cyclohexane	Disordered	221
	n-heptane	Disordered	221
Pt(S)-[7(111)×(310)]		Disordered	221
		Disordered	221
		Disordered	221
		Disordered	221
		Disordered	221
		Disordered	221

TABLE VII. Surface Structure Formed by Adsorption of Organic Molecules (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Pt(S)-[9(111)×(100)]	toluene	Disordered	221
		Graphite Overlayer	221
	C ₂ H ₄	Adsorbed	221
	benzene	Disordered	221
		$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$ -C	221
		Graphite Overlayer	221
	cyclohexane	Disordered	221
	n-heptane	(2×2)	221
		$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$	221
		(5×5)-C	221
Pt(S)-[9(111)×(111)]		(2×2)-C	221
		$\begin{pmatrix} 1 & 1 \\ -1 & 2 \end{pmatrix}$ -C	221
	toluene	2(1 dimensional order)-C	221
		3(1 dimensional order)	221
		Graphite Overlayer	221
	C ₂ H ₄	Disordered	120
		Graphite Overlayer	398,399
		(2×2)	685
	C ₂ H ₄	Graphite Overlayer	426
		(511),(311) and (731) facets	426
Re(0001)	C ₂ H ₂	Disordered	436,664
		(2×√3)R30°-C	436
	C ₂ H ₄	Disordered	436,664
Re(S)-[14(0001)×(10 $\bar{1}$ 1)]		(2×√3)R30°-C	436
	C ₂ H ₂	Disordered	664
	C ₂ H ₄	(2×√3)R30°	664
Re(S)-[6(0001)×(16 $\bar{7}$ 1)]	C ₂ H ₂	Disordered	664
	C ₂ H ₄	Disordered	664
Rh(100)	C ₂ H ₂	c(2×2)	231
		c(2×2)-C ₂ H+C ₂ H ₃	1880
	C ₂ H ₄	c(2×2)	231
		c(2×2)-C ₂ H+C ₂ H ₃	1878
		(2×2)-C ₂ H	1878
		c(2×2)-C	231,1403
		Graphite Overlayer	231,1403
	CO+C ₂ H ₄	c(4×2)-CO+C ₂ H ₃	1878
		split c(2×2)-CO+C ₂ H ₃	1878
	C ₆ H ₆	c(4×4)	1879
	C ₆ H ₆ +CO	c(2√2×4√2)R45°-CO+C ₆ H ₆	1879
		c(2×2)	1879

TABLE VII. Surface Structure Formed by Adsorption of Organic Molecules (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Rh(111)	C_2H_2	$c(4 \times 2)$	231,831
		(2×2)	831
	C_2H_2+CO	$c(4 \times 2)-CO+C_2H_2$	1844,1881
	C_2H_2+Na	Disordered	1876
	C_2H_4	$c(4 \times 2)$	231,831,1256,1372
		$*(2 \times 2)-C_2H_3$ (ethynylidyne)	831,1256*,1372
		Partially Ordered	955
		$(8 \times 8)-C$	231
		$(2 \times 2)R30^\circ-C$	231
		$(\sqrt{19} \times \sqrt{19})R23.4^\circ-C$	231
		$(2\sqrt{3} \times 2\sqrt{3})R30^\circ-C$	231
		$(12 \times 12)-C$	231
		$c(4 \times 2)-CO+C_2H_3$	1881
		$*c(4 \times 2)-NO+C_2H_3$	1877*
	$C_2H_4+H_2$	$c(4 \times 2)-CCH_3$	955
		$c(4 \times 2)$	1372
	C_3H_6+CO	$(2 \times 2)+c(4 \times 2)$	1256
		$(2\sqrt{3} \times 2\sqrt{3})R30^\circ-CO+C_3H_5$	1884
	CH_3OH	Disordered	988
	benzene	$(2\sqrt{3} \times 3)rect$	1842,1892
		$(\sqrt{7} \times \sqrt{7})R19.1^\circ$	1892
	benzene+CO	$*c(2\sqrt{3} \times 4)rect$	1068,1416,1453,1842,1856*,1892
		$= \begin{pmatrix} 3 & 1 \\ 1 & 3 \end{pmatrix} - C_6H_6 + CO$	
	benzene+Na	$*(3 \times 3)-C_6H_6+2CO$	1068,1842,1855*,1892
		$(\sqrt{3} \times \sqrt{3})R30^\circ+(2\sqrt{3} \times 3)rect$	1876
	C_6H_5F+CO	(3×3)	1844
	methylacetylene	$c(4 \times 2)$	1372
	naphthalene	$(3\sqrt{3} \times 3\sqrt{3})R30^\circ$	1068
		(3×3)	1068
	propylene	$(2 \times 2)+(2\sqrt{3} \times 2\sqrt{3})R30^\circ$	1372
		$(2\sqrt{3} \times 2\sqrt{3})R30^\circ$	1372
Rh(331)	C_2H_2	$\begin{pmatrix} -1 & 1 \\ 3 & 0 \end{pmatrix}$	402
	C_2H_4	$\begin{pmatrix} -1 & 1 \\ 3 & 0 \end{pmatrix}$	402,722
Rh(S)-[6(111) $\times$ (100)]	C_2H_2	Graphite Overlayer	402,722
		Disordered	402
		Disordered	402,722
		(111),(100) facets	402,722

TABLE VII. Surface Structure Formed by Adsorption of Organic Molecules (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Ru(0001)	C ₂ H ₆	Disordered	692
	cyclopropane	Disordered	692,1111
	cyclohexane	Disordered	692,1112
		(1×1)	692
Si(111)	cyclooctane	(1×1)	692
	C ₂ H ₂	Disordered	437
	CH ₃ OH	(7×7)-CH ₃ O+H+CH ₃ OH	837
		Disordered	988
Si(311)	C ₂ H ₂	Disordered CH ₃ O+H	942
		c(1×1)	135
		(2×1)	135
		(3×1)	135
	C ₂ H ₄	c(1×1)	135
		(2×1)	135
		(3×1)	135
		(3×1)	135
Ta(100)	C ₂ H ₄	Adsorbed	328
W(100)	CH ₄	(5×1)-C	41
	C ₂ H ₂	Disordered	700
		(5×1)-C	700,901
		c(3×2)-C	700
	propylene	c(2×2)-C	700
		$\begin{pmatrix} 3 & 0 \\ 1 & -1 \end{pmatrix}$ -C	887
		(5×1)-C	887
		(5×1)-C	887
W(110)	C ₂ H ₂	(2×2)-C ₂ H ₂	1072
		c(2×2)-C ₂ H ₂	1072
		(15×3)R14°-C	1072
		(15×3)Rα-C	41
W(111)	C ₂ H ₄	(15×12)Rα-C	41
		(6×6)-C	41
		(1×1)	1595
		(1×1)	1595
W(211)	propylene	c(6×4)-C	887
ZnO(10 $\bar{1}$ 0)	C ₆ H ₆	c(2×2)-C ₆ H ₆	632,620
		c(4×3)-C ₆ H ₆	632,620

TABLE VIII. Coadsorbed Overlayer Structures

Substrate	Adsorbate	Surface Structure	Reference
Ag(100)	Cl ₂ +K	c(2×2)-K/Cl	673
	K+O ₂	$\begin{pmatrix} 1 & 1 \\ -5 & 4 \end{pmatrix}$	658
		Hexagonal Overlayer	658
Ag(110)	O(ad.)+H ₂ O	c(2×2)-OH	1034
	C ₂ H ₄ +O ₂	(2×1)-O	1001
	H ₂ O+Li ⁺	Complex	1557
	O(a)+C ₂ H ₂	c(2×6)-acetylide	1335,1398
		(2×2)-acetylide	1335,1398
		(2×3)-acetylide	1335,1398
		(1×1)-C	1335
	O(a)+SO ₂	c(6×2)-SO ₃	1027,1371
		(1×2)-SO ₄	1371
	O ₂ +H ₂ O	(1×2)-OH	878
		(1×3)-OH	878
Ag(111)	CO+O ₂	(2×√3)-(CO+O ₂)	27
Bi(0001)	O ₂ +K	√3+BiO(0001)layer	1288
C(0001), graphite	Ar+Xe	(√3×√3)R30°-Ar,Xe	1193
Co(100)	H ₂ S+C	(2×2)-S,C	1539
Cr(100)	C,O,N	c(2×2)	1126
Cu(110)	Br(a)+H ₂ O	(3×2)	1557
	C+O ₂	(2×1)	1695
	Ni(CO ₄)+CO	(1×1)	1048
	O(a)+CO	Disordered	1066
	O(a)+H ₂ O	(2×1)-O,H ₂ O	1023
		c(2×2)-O,H ₂ O	1023
		(2×1)-H ₂ O	1270
		(1×1)-H ₂ O,OH	1270
		(2×1)-OH,O	1270
Cu(111)	Ni(CO) ₄ +CO	(1×1)	1048
	O ₂ +HCN	Disordered	1244
	O(a)+CO	Disordered	1066
	O(a)+CO ₂	(2×2)	1142
Fe(110)	K+O ₂	c(4×2)	786
Fe(111)	N(a)+K	(3×3)-K,N	1350
Fe-18% Cr-12% Ni(111)	I(a)+H ₂ O	Oxide Not Formed	1249
	H ₂ O(a)+I ₂	Adsorbed	1249
GaAs(100)	As ₄ ,Ga	(2×4)	1365
		(4×6)	1365
		c(8×2)	1365
		(4×1)	1365
		(3×1)	1365
	HCl,H ₂ O	(1×1)	1518
	Pb,As ₄	(1×2)-Pb	1387
Hg(110)	O(ad)+SO ₂	c(6×2)-SO ₃	1027,1371
		(1×2)-SO ₄ etc.	1371
	O ₂ +H ₂ O	(1×2)-OH	878
		(1×3)-OH	878
Mo(100)	Cs+O ₂	c(2×2)+(4×1)	932
		(4×1)	932
		c(2×2)	932

TABLE VIII. Coadsorbed Overlayer Structures (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Mo(111)	H ₂ S+O ₂	($\sqrt{5} \times \sqrt{5}$)R26.6°-S,O	917
	O(a)+CO	(2×1)-O	817
	O(a)+CO ₂	(2×1)-O	817
	O(a)+C ₂ H ₄	(2×1)-O	817
	O(a)+HCOOH	(2×1)-O,C	1155
	N ₂ +NH ₃	Disordered	1203
	N ₂ +NH ₃	(433)facet	1203
Ni(100)		c(3×2)-N/Mo(433)	1203
	C(a)+O ₂	c(2×2)-O	1177
	CO+H ₂	c(3×3)	301
	H ₂ +CO	c(2×2)-CO,H	1202
		c($\sqrt{2} \times \sqrt{2}$)R45°-CO,H	1202
	H ₂ S,H ₂	c(2×2)-S	1121
	H ₂ S+Na	*c(2×2)Na+c(2×2)S	1887*
Ni(110)		*(2×2)Na+c(2×2)S	1887*
		(2×2)Na+(2×2)S	1887
	O(a)+CO	c(2×2)-C,O	1356
	S,C	(1×1)	1561
	CO+O ₂	(3×1)-(CO+O ₂)	91
	O ₂ +H ₂ O	(2×1)-OH	1011
	Ni(CO) ₄ ,CO	($\sqrt{7}/2 \times \sqrt{7}/2$)R19°-CO	1150
Ni(111)		c(4×2)-CO	1150
	O(a)+H ₂ O	No New Features	1308
	O(a)+NO	(2×2)	676
Ni(331)	O,CO	(2×3)	1318
Pd(100)	H(a)+O ₂	Adsorbed	1163,1454
	H ₂ ,O ₂	Disordered	1163
		(2×2)-O,H	1163
	O ₂ +CO	Disorderd	939
	O ₂ +H ₂ O	(2×1)-OH	940
	O(a)+H ₂	Not Adsorbed	1163,1454
	O ₂ +CO	($\sqrt{3} \times \sqrt{3}$)R30°	691
Pt(100)		(2×1)	691
	CO+H ₂	c(2×2)-(CO+H ₂)	72,74
	CO+O ₂	(1×1) diffuse	909
		c(2×2)-CO+(3×1)-O	928
	H ₂ O+HBr	c(2 $\sqrt{2} \times \sqrt{2}$)R45°-Br,HBr	1258
	Br,HBr(a)+H ₂ O	Not Adsorbed	1258
	Br,HBr(a)+NH ₃	No Affinity	1258
Pt(110)	I(a)+Ag	($\sqrt{2} \times \sqrt{2}$)R45°-I,Ag	1390
		(10 $\sqrt{2} \times 10\sqrt{2}$)R45°-I,Ag	1390
		($\sqrt{34} \times \sqrt{34}$)R31°-I,Ag	1390
	SO ₂ (a)+NH ₃	(1×1) Diffuse	1258
	CO+NO	(1×1)-CO+NO	364

TABLE VIII. Coadsorbed Overlayer Structures (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Pt(111)	$C_2H_2+H_2$ (O)+ C_2H_4	$*(2\times 2)-C_2H_3$	824,1316,1587
		(2×2)	1313
		Ordered	1313
	benzene+CO	$\begin{pmatrix} -2 & 2 \\ 5 & 5 \end{pmatrix} = \begin{pmatrix} 4 & -2 \\ 0 & 4 \end{pmatrix}$	221,428,429
		$*\begin{pmatrix} 4 & -2 \\ 0 & 5 \end{pmatrix} = \begin{pmatrix} -2 & 2 \\ 4 & 4 \end{pmatrix}$	428,429,1854*
		$= (2\sqrt{3}\times 4)\text{rect}-2C_6H_6+4CO$	
	DMSO(a)+ I_2	Ordered	1258
	DMSO(a)+pyridine	Not Adsorbed	1258
	I(a)+pyridine	Not Adsorbed	1258
		Pyridine Adsorbed	1258
	I(a)+acetonitrile	Acetonitrile Not Adsorbed	1258
	I(a)+DMSO	DMSO Not Adsorbed	1258
	I_2 +DMSO	$c(2\times 4\sqrt{3}/3)-I,DMSO$	1258
	pyridine(a)+DMSO	Adsorbed	1258
	pyridine(a)+ H_2O	Adsorbed	1258
	pyridine(a)+ I_2	I_2 Adsorbed	1258
	$H_2+C_2N_2$	Disorderd	1002
	Cl_2+Br_2	$c(2\times 4)-Cl,Br$	610
		$(\sqrt{3}\times \sqrt{3})R30^\circ-Cl,Br$	610
		$(3\times 3)-Cl,Br$	610
		$(\sqrt{7}\times \sqrt{7})R19.1^\circ$	610
	CO+ O_2	$(\sqrt{3}\times \sqrt{3})R30^\circ(\text{misfit})$	909
	H_2+O_2	$(\sqrt{3}\times \sqrt{3})R30^\circ$	11
	$I_2(a)+HBr$	HBr Not Adsorbed	1258
	I(a)+Cu	$(3\times 3)-I,Cu$	1556
		$(10\times 10)-I,Cu$	1556
	I_2+Ag	$(3\times 3)-Ag,I$	937,1106,1391
		$(5\times 5)-Ag,I$	937
		$(17\times 17)-Ag,I$	937
		$(\sqrt{7}\times \sqrt{7})+(3\times 3)$	1391
		$(\sqrt{3}\times \sqrt{3})R30^\circ-Ag,I$	1391
		Disorderd	1255
	K+CO	$(4\times 4)-K,O$	1238,1337
	K+ O_2	(8×2)	1337
		(10×2)	1337
		K_2O	1337
		$(2\times 2)-O$	1040
		(4×4) Potassium Oxide	1337
		(8×2) Potassium Oxide	1337
		(10×2) Potassium Oxide	1337
		Compressed (CO)	1348
		$c(4\times 2)-CO+C_2H_3$	1878
		split $c(2\times 2)-CO+C_2H_3$	1878
Rh(100)	CO(a)+ D_2 CO+ CH_4	$c(2\sqrt{2}\times 4\sqrt{2})R45^\circ-CO+C_6H_6$	1879
		$c(2\times 2)$	1348
	C_6H_6+CO	Disordered	1025
	D(a)+CO	$(2\sqrt{3}\times \sqrt{3})R30$	1082
	NO+ D_2	Complex	1082
	Na+ H_2O		

TABLE VIII. Coadsorbed Overlayer Structures (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Rh(111)		$(\sqrt{3} \times 7)\text{rect}$	1844
	CO+Na	$c(4 \times 2)\text{--CO+Na}$	1844
	H ₂ +CO	(2×2)	829
		$(\sqrt{3} \times \sqrt{3})\text{R}30^\circ$	829
	C ₂ H ₂ +H ₂	$c(4 \times 2)$	231,831
	C ₂ H ₂ +CO	$c(4 \times 2)\text{--CO+C}_2\text{H}_2$	1844,1881
	C ₂ H ₂ +Na	Disordered	1876
	C ₂ H ₄ +H ₂	$c(4 \times 2)\text{--CCH}_3$	955
		$c(4 \times 2)$	1372
		$(2 \times 2)+c(4 \times 2)$	1256
	C ₃ H ₆ +CO	$(2\sqrt{3} \times 2\sqrt{3})\text{R}30^\circ\text{--CO+C}_3\text{H}_5$	1884
	Benzene+CO	$*c(2\sqrt{3} \times 4)\text{rect}$	1068,1416,1453,1842,1856*
		$= \begin{pmatrix} 3 & 1 \\ 1 & 3 \end{pmatrix} \text{--C}_6\text{H}_6\text{+CO}$	
		$*(3 \times 3)\text{--C}_6\text{H}_6\text{+2CO}$	1068,1842,1855*
	Benzene+Na	$(\sqrt{3} \times \sqrt{3})\text{R}30^\circ+(2\sqrt{3} \times 3)\text{rect}$	1876
Ru(0001)	C ₆ H ₅ F+CO	(3×3)	1844
	NO+CO	Disordered	1876
	CO+O ₂	(2×2)	768
Si(111)	Na+CO	$(2\sqrt{3} \times 2\sqrt{3})\text{R}30^\circ$	976
	Ag(a)+H	$(\sqrt{3} \times \sqrt{3})\text{R}30^\circ$	1536
W(100)	CO+N ₂	$(4 \times 1)\text{--(CO+N}_2\text{)}$	82
	O ₂ +H ₂	$(\sqrt{2} \times \sqrt{2})+(4 \times 1)\text{--O,H}$	815
W(110)	CO+O ₂	$c(11 \times 5)\text{--(CO+O}_2\text{)}$	93
	Pd(1 ML)+CO	Not Adsorbed	1218
	Pd(2.2 ML)+O ₂	$(2 \times 2)\text{--O}$	1218
W(221)	CO+O ₂	$(1 \times 1)\text{--(CO+O}_2\text{)}$	108
		$(1 \times 2)\text{--(CO+O}_2\text{)}$	108

TABLE IX. Physisorbed Overlayer Structures

Substrate	Adsorbate	Surface Structure	Reference
Ag(110)	Xe	Hexagonal Overlayer	159
Ag(111)	Kr	Hexagonal Overlayer	156
	Xe	Hexagonal Overlayer	156,157,158,159
			160
Ag(211)	Xe	Hexagonal Overlayer	159
Au(100)	Xe	Disordered	252
C(0001), graphite	Ar	$(\sqrt{3} \times \sqrt{3})R30^\circ$ -Ar	720,960
	Ar	Incommensurate	1882
	Ar+Xe	$(\sqrt{3} \times \sqrt{3})R30^\circ$ -Ar,Xe	1193
	CF ₄	(2×2) -CF ₄	1194
		Close to (2×2)	1404
	CH ₄	$(\sqrt{3} \times \sqrt{3})R30^\circ$	1018
	C ₂ H ₆	$(4 \times \sqrt{3})$ -C ₂ H ₆	1191
		(2×2) -C ₂ H ₆	1191
		$(10 \times 2\sqrt{3})$ -C ₂ H ₆	1191
		$(\sqrt{3} \times \sqrt{3})$ -C ₂ H ₆	1191
	CO	$(\sqrt{3} \times \sqrt{3})R30^\circ$ -CO	884
		$(2\sqrt{3} \times 2\sqrt{3})R30^\circ$ -CO	889
		$(2\sqrt{3} \times \sqrt{3})R30^\circ$	884
		Incommensurate (2×2)	884
	H ₂	$(\sqrt{3} \times \sqrt{3})R30^\circ$ -H ₂	1283
	Kr	$(\sqrt{3} \times \sqrt{3})R30^\circ$ -Kr	166,167,174,721
			828,960,1616
		Incommensurate	1616
	N ₂	$(2\sqrt{3} \times 2\sqrt{3})R30^\circ$ -N ₂	889
		$(\sqrt{3} \times \sqrt{3})R30^\circ$	1064
		$(\sqrt{3} \times \sqrt{3})R30^\circ + (2 \times 1)$	1435
		Commensurate	1190,1512,1883
		Incommensurate	1443,1190,1512,1883
	Ne	Incommensurate	629
		$(\sqrt{3} \times \sqrt{3})R30^\circ$ rotated by 17°	629
		Layer+Island	960
		Ordered	1338
	NO	Incommensurate	1602
	O ₂	Triangular	1883
		Centered-Parallelogram-O ₂	1200,1425,1883
		Physisorbed	1411
	Xe	$(\sqrt{3} \times \sqrt{3})R30^\circ$ -Xe	165,618,960,1038,1201
Cu(100)	Xe	Hexagonal Overlayer	159
		Disordered	741
Cu(110)	Kr	$c(2 \times 8)$ -Kr	1304,1331
	Xe	$c(2 \times 2)$ -Xe	159,1331,1611
		Hexagonal Overlayer	159,1611
Cu(111)	Xe	$(\sqrt{3} \times \sqrt{3})R30^\circ$ -Xe	159
Cu(211)	Kr	Hexagonal Overlayer	156
	Xe	Hexagonal Overlayer	156
Cu(311)	Xe	Hexagonal Overlayer	394
Cu(610)	Xe	(2×6) -Xe	790
Ir(100)	Kr	(3×5) -Kr	283
		Kr(111)	283
NaCl(100)	Xe	Hexagonal Overlayer	289
Ni(100)	Xe	Partially Ordered	1268

TABLE IX. Physisorbed Overlayer Structures (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Pd(100)	Kr	Liquid-like	913
	Xe	Hexagonal Overlayer	311
		Liquid-like	913
Pd(110)	Xe	Hexagonal	743
Pd(S)-[8(100)×(110)]	Xe	1-D Periodicity	1100
Pt(111)	Xe	($\sqrt{3} \times \sqrt{3}$)R30°-Xe	846
		Hexagonal Overlayer	846
		(1×1)	1125
Si(111)	Kr	(1×1)	1125
	Xe	(1×1)	1125
W(110)	Xe	(2×2)-Xe	713
		Disordered	713
		Disordered	1026
ZnO(000 $\bar{1}$)	Xe	Hexagonal	1026
ZnO(10 $\bar{1}$ 0)	Xe		

TABLE X. Surface Structures on High-Miller-Index (Stepped) Substrates†

Substrate	Adsorbate	Surface Structure	Reference
Ag(211)	Xe	Hexagonal Overlayer	159
Ag(331)	Cl ₂	(6×1)-Cl	393
	O ₂	Disordered	393
		Ag(110)-(2×1)-O	393
Al(311)	[clean]	*(1×1)	860*
Au(210)	Pb	(1×1)	497
Au(311)	Pb	(5×3)	496
		(3×3)-Pb	730
		(3×4)-Pb	730
Au(320)	Pb	(3×3)	496
		(1×1)	730
Au(511)	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$	444
		$\begin{pmatrix} 2 & 0 \\ 1 & 3 \end{pmatrix}$	444
	Pd	c(2×2)	683
		c(7√2×√2)R45°	683
		c(3√2×√2)R45°	683
		c(6×2)	683
Au(711)	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	444
		$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$	444
	Pd	c(2×2)	683
		c(7√2×√2)R45°	683
		c(3√2×√2)R45°	683
		c(6×2)	683
Au(911)	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	444
		$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$	444
	Pd	c(2×2)	683
		c(7√2×√2)R45°	683
		c(3√2×√2)R45°	683
		c(6×2)	683
Au(11,1,1)	Pb	$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$	444
		$\begin{pmatrix} 2 & 0 \\ -1 & 3 \end{pmatrix}$	444
Au(S)-[6(111)×(100)]	O ₂	Oxide	161
Bi(1,0,1,16)	[clean]	(1×1)	1109

†Organic overlayer structures are not included. See Table VII for these structures.

TABLE X. Surface Structures on High-Miller-Index (Stepped) Substrates (Continued)

Substrate	Adsorbate	Surface Structure	Reference
C(0001) [stepped]	K	(1×1)-K	1433
	K	(2×2)-K	1433
	K	No LEED Superstructure	1540
Co(10 $\bar{1}$ 2)	[clean]	(1×1)	698,1584
	CO	Co ₃ C(001)-(2×3)	698
Cu(210)	O ₂	(3×1)-CO	698
		(410),(530)facets	259
		Streak pattern	688
		(2×1)-O	688
	N	(3×1)-O	688
		c(11 $\sqrt{2}$ × $\sqrt{2}$)R45°-N	794
Cu(211)	(2×3)-N		794
		Hexagonal Overlayer	156
	O ₂	Cu(S)[5(111)×2(100)]	958
	Facet		958
	Pb	(4×1)	484
	Xe	Hexagonal Overlayer	156
Cu(311)	[clean]	*(1×1)	925,1473,1782*
	CO	Adsorbed	394
	Pb	$\begin{pmatrix} 3 & 1 \\ -2 & 1 \end{pmatrix}$	484
		(4×2)	484
	Xe	Hexagonal Overlayer	394
	O ₂	(1×1)-O	1257
Cu(410)	O ₂	(1×1) Streaked	958
Cu(511)	[clean]	!(1×1)-O [“c(2×2)-O” on a terrace]	958!,1133,1257
		!(1×1)-2O	958!
	Pb	(1×1)	925
	Pb	(4×1)	482
	O ₂	(1×1)-O	1257
	Xe	(2×6)-Xe	790
Cu(610)	[clean]	(1×1)	925
	Pb	(4×1)	482,484
Cu(711)	O ₂	(410),(100)facets	259
Cu(841)	CO	Not Adsorbed	132
Cu(S)-[3(100)×(100)]	N ₂	(1×2)-N	132
	CO	Not Adsorbed	132
Cu(S)-[4(100)×(100)]	N ₂	(1×3)-N	132
	O ₂	(1×1)-O	132
Cu(S)-[4(100)×(111)]	H ₂ S	8(1d)-S	35
Fe(210)	[clean]	*(1×1)	1530,1767*
Fe(211)	[clean]	*(1×1)	1460*,1531
Fe(310)	[clean]	*(1×1)	1410*,1530
Fe(12,1,0)	N ₂	Reconstruction by Nitride Formation	669
GaAs(211)	[clean]	(110)facets	936
Ge(210)	[clean]	(2×2)	804,1683
Ge(211)	[clean]	(3×1) (311)facets	936
		(1×2)	804,1683
Ge(311)	[clean]	(3×1)	804,1683
Ge(331)	[clean]	(5×1)	804,1683
Ge(510)	[clean]	(1×2)	804,1683

TABLE X. Surface Structures on High-Miller-Index (Stepped) Substrates (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Ge(511)	[clean]	(3×1)	804,1683
Ge(551)	[clean]	(5×2)	804,1683
Ir(S)-[6(111)×(100)]	CO	Disordered	182
	H ₂	Adsorbed	187
	H ₂ O	Not Adsorbed	182
	O ₂	(2×1)-O	182
	O ₂	Disordered	1624
LaB ₆ (210)	O ₂	Disordered	1624
Mo(100)[Stepped]	Cs	(2×2)	932
		c(2×2)	932
	Cs(a)+O ₂	c(2×2)	932
		Disordered	932
Mo(211)	Ba	(1×5)	1591,1675
		(4×2)	1591
	Cs	c(2×1/J), 0.15 < J < 0.64	1590
		c(2×2)	1590
	CO	Disordered	105
	H ₂	(1×2)-H	105
	La	Linear Chains	1447
		c(2×2)	1447
		c(2×4/3)	1447
	Li	(1×4)-Li	1593
		(1×2)-Li	1593
		(1×1)-Li	1593
		Not Adsorbed	105
	N ₂	(1×4)-Na	1684
		(1×3)-Na	1684
		(1×2)-Na	1684
		(1×3/2)-Na	1684
		(2×1)-O	105
	O ₂	(1×2)-O	105
		(1×3)-O	105
		c(4×2)-O	105
		(1×9)-Sr	1594
		(1×5)-Sr	1594
	Sr	(4×2)-Sr	1594
		(110)Terrace+(310)Step	1688
Nb(750)	O ₂	(110)Terrace+(310)Step	1688
Ni(210)	N ₂	Ni(100)-(6√2×√2)R45°-N	395
		c(11√2×√2)R45°-N	794
		(2×3)-N	794
		Ni(110)-(2×3)-N	395
	O ₂	Facets	395,794
	O ₂	NiO	1351
	[clean]	*(1×1)	900*,1473,
			1885*,1886*
	[clean]	(1×1)	1247,1893
		(1×2)-S	1893
		(2×5)-S	1893
		(2×1)-S	1893
Ni(hk0)[(210)to(410)]	O,CO	(2×3)	1893
	[clean]	Ordered	871
		Facets	871
	O ₂	(2×2)	1055
Ni(S)-[3(100)×(111)]	H ₂ S	(2×2)	1055
Ni(S)-[5(100)×(111)]	[clean]	Streaks	1055
	CO	Streaks Disappear	1055

TABLE X. Surface Structures on High-Miller-Index (Stepped) Substrates (Continued)

Substrate	Adsorbate	Surface Structure	Reference
	H ₂ S	Streaks Disappear	1055
Ni ₄ Mo(211)	[clean]	Ordered	1115
Pd(111) Stepped	NO	c(4×2)-NO	1236
		(2×2)-NO	1236
Pd(210)	CO	(1×1)-CO	209,210
		(1×2)-CO	209,210
Pd(311)	CO	(2×1)-CO	209
		3(1 dimensional order)-CO	209
Pd(331)	O ₂	Disordered	675
		2(1 dimensional order)	675
		$\begin{pmatrix} 1 & 2 \\ 2 & 0 \end{pmatrix}$ -O	675
	NO	Disordered	675
Pd(S)-[8(100)×(110)]	Xe	1-D Periodicity	1100
Pd(S)-[9(111)×(111)]	CO	($\sqrt{3} \times \sqrt{3}$)R30°-CO	209
		Hexagonal Overlay	209
Pt(321)	[clean]	Ordered	1212
	O ₂	Disordered	760
Pt(654)	O ₂	($\sqrt{3} \times \sqrt{3}$)R30°-O	760
Pt(997)	[clean]	(1×1)	1226,1278
	O ₂	Pt(S)-[(17(111)×2(111))-O	1226,1278
Pt(12,9,8)	O ₂	($\sqrt{3} \times \sqrt{3}$)R30°-O	760
Pt(12,11,9)	[clean]	(1×1)	1226
Pt(62,62,60)	[clean]	(1×1)	1226
		(2×2)-O	760
Pt(S)-[4(111)×(100)]	CO	Disordered	899
	H ₂	Facets	221
Pt(S)-[5(100)×(111)]	O ₂	(1×1)-O	708,1171
		(2 $\sqrt{2} \times \sqrt{2}$)R45°-O	708,1171
		Terrace Broadening and Diffused Background	1171
Pt(S)-[6(111)×(111)]	I ₂	(3×3)or($\sqrt{3} \times \sqrt{3}$)R30° Domains	930
	NH ₃	Adsorbed	626
	O ₂	($\sqrt{3} \times \sqrt{3}$)R30°-PtO ₂ (0001)	805
		(4 $\sqrt{3} \times 2\sqrt{3}$)R30°-PtO ₂ (0001)	805
Pt(S)-[6(111)×(100)]	CO	Disordered	120
	H ₂	2(1 dimensional order)-H	120,221
		Adsorbed	396
		Pt(S)-[11(111)×2(100)]	396
	K(a)+O ₂	(4×4) Potassium Oxide	1337
		(8×2) Potassium Oxide	1337
		(10×2) Potassium Oxide	1337
	O ₂	2(1 dimensional order)-O	120
		Pt(111)-(2×2)-O	215,708,1171
		Pt(111)-($\sqrt{3} \times \sqrt{3}$)R30°-O	215
		Pt(111)-($\sqrt{79} \times \sqrt{79}$)-R18°7'-O	215
		Pt(111)-(4×2 $\sqrt{3}$)-R30°-O	215
		Pt(111)-3(1 dimensional order)-O	215
		Reconstructed (2×2)	1171
		Terrace Broadening	

TABLE X. Surface Structures on High-Miller-Index (Stepped) Substrates (Continued)

Substrate	Adsorbate	Surface Structure	Reference
Pt(S)-[7(111)×(310)]	O ₂	($\sqrt{3} \times \sqrt{3}$)-R30°-O	760
		(2×2)-O	760
Pt(S)-[9(111)×(100)]	H ₂	2(1 dimensional order)-H	221
	H ₂ S	(2×2)-S	1339
		($\sqrt{3} \times \sqrt{3}$)-R30°-S	1339
Pt(S)-[9(111)×(111)]	C ₂ N ₂	Disordered	685
		Disordered	120,685
	CO	($\sqrt{3} \times \sqrt{3}$)-R30°-CO	685
		c(4×2)-CO	685
		(2×2)-H	120
	H ₂	Adsorbed	400
		Disordered	228
	N	(2×2)-O	397,398,399,685
	O ₂	Not Adsorbed	120
		Disordered	401
Pt(S)-[12(111)×(111)]	NH ₃	(2×2)-NO	401
	NO	(2×2)-O	689
	O ₂	(2×2)-O	708,1171
Pt(S)-[13(111)×(310)]	O ₂	($\sqrt{3} \times \sqrt{3}$)-R30°-O	708
		Reconstructed (2×2)	1171
		Terrace Broadening	
Pt(S)-[20(111)×(111)]	O ₂	(2×2)-O	1013
Re(S)-[6(0001)×(16 $\bar{7}$ 6)]	O ₂	ReO ₃ Reconstruction	1654
Re(S)-[14(0001)×(10 $\bar{1}$ 1)]	CO	(2×2)-CO	230
		(2×1)-C	230
	H ₂	Disordered	663
Re(S)-[(14(0001)×(16 $\bar{7}$ 1)]	H ₂	Disordered	664
Re(S)[16(0001)×2(10 $\bar{1}$ 1)]	O ₂	(2×2)	1515
Rh(331)	[clean]	(1×1)	839
	CO	$\begin{pmatrix} 1 & 2 \\ 5 & -1 \end{pmatrix}$ -CO	402,722
		$\begin{pmatrix} 1 & 2 \\ 2 & 0 \end{pmatrix}$ -CO	402
		Hexagonal Overlayer	402
	CO ₂	$\begin{pmatrix} 1 & 2 \\ 5 & -1 \end{pmatrix}$ -CO	402
		$\begin{pmatrix} 1 & 2 \\ 2 & 0 \end{pmatrix}$ -CO	402,722
		Hexagonal Overlayer	402,722
	H ₂	Adsorbed	402
		(1×1)	722
	NO	Disordered	402
	O ₂	$\begin{pmatrix} -1 & 1 \\ 3 & 0 \end{pmatrix}$	402
		2(1 dimensional order)-O	402,722

TABLE X. Surface Structures on High-Miller-Index (Stepped) Substrates (Continued)

Substrate	Adsorbate	Surface Structure	Reference
		$\begin{pmatrix} 1 & 2 \\ 2 & 0 \end{pmatrix} - \text{O}$	402,722
		$\begin{pmatrix} 1 & 2 \\ 7 & -1 \end{pmatrix} - \text{O}$	402,722
Rh(S)-[6(111)×(100)]		Facets	402
	CO	($\sqrt{3} \times \sqrt{3}$)-R30°-CO	402,722
		(2×2)-CO	402
	CO ₂	($\sqrt{3} \times \sqrt{3}$)-R30°-CO	402
		(2×2)-CO	402,722
	H ₂	Adsorbed	402
		(1×1)	722
	NO	(2×2)-NO	402,722
Si(111)[Stepped]	O ₂	(2×2)-O	402,722
		Rh(S)-[12(111)×2(100)]-(2×2)-O	402
		Rh(111)-(2×2)-O	402
	Ni	Si(221)-(2×2)	964
	Pd	Si(221)-(2×2)	964
	Si+laser	Unchanged	1392
	Si(210) [clean]	(2×2)	803,1685
	Si(211) [clean]	Complex	1317
Si(311)		(4×2)	803,936,1685
	Ga	Ordered	1317
	H ₂	Ordered (facet)	1317
	[clean]	(3×2)	803,1685
	NH ₃	Adsorbed	238
	Si(320) [clean]	(1×2)	803,1685
		(1×1)	803
		Facet	803
Si(331)	[clean]	(13×1)	803
		(13×2)	1685
	Si(510) [clean]	(1×2)	803,1685
	Si(511) [clean]	(3×1)	803,1685
	Si(S)-[14(111)×(112)]	(1×1)	1517
	Si(hkl)(001 zone)	Facets	892
	Au	Diffuse	892
		Facets	892
Ta(211)		3d-Au clusters	892
	CO	Disordered	101,102
		(3×1)-O	102
	H ₂	(1×1)-H	102
	N ₂	Disordered	102
		(311) facets	102
	O ₂	(3×1)-O	101,102
	[clean]	(1×1)	1020
Ti ₂ O ₃ (047)		Oxide	101,102
	W(100)[Stepped]	($\sqrt{2} \times \sqrt{2}$)R45°	1243
	W(210)	(2×1)-CO	138,575,1647
		(1×1)-CO	138
	N ₂	(2×1)-N	131,575,887,1647

TABLE X. Surface Structures on High-Miller-Index (Stepped) Substrates (Continued)

Substrate	Adsorbate	Surface Structure	Reference
W(211)	[clean]	(1×1)	887
		(1×2)	1147
	Ag	(1×1)-Ag	969
	Au	(1×1)	969
		(1×2)	969
		(1×3)	969
		(1×4)	969
	C	c(10×4)-C	887
		c(6×4)-C	887
	CO	c(2×4)-C,O	887
	H ₂ S	c(2×6)-S	887
		c(2×2)-S	887
	Li	(4×1)	518,520
		(3×1)	518,520
		(2×1)	518,520
		Incoherent	518,520
		(1×1)	518,520
		[clean]	(2×2)
		(1×7)-Mg	1657
	Mg	(3×3)-Mg	1657
		(2×1)	521
	Na	Compressed(2×1)	521
	O ₂	(2×1)-O	15,106,107,108,403,404,887,1415,1431
		(1×1)-O	106,107,403,404,887
		(1×2)-O	15,106,404,887
		(1×3)-O	106
		(1×4)-O	106,404
		(1×n)-O (n=3-7)	887
		(2×1)	553
		(1×1)	553
W(221)	CO	Disordered	108
		c(6×4)-CO	108
		(2×1)-CO	108
		c(2×4)-CO	108
	CO+O ₂	(1×1)-CO+O ₂	108
		(1×2)-CO+O ₂	108
	H ₂	(1×1)-H	112
	Na	Compressed(2×1)	521
		(2×1)	521
	Ni	(1×1)-Ni	970
		(6×1)-Ni	970
	NH ₃	c(4×2)-NH ₂	113
	O ₂	(2×1)-O	15,106,107,108,403,404
		(1×2)-O	15,106,404
		(1×1)-O	106,107,403,404
		(1×3)-k	106
		(1×4)-O	106,404
W(310)	N ₂	(2×1)-N	131
		c(2×2)-N	131
	O ₂	(2×1)-O	1389

TABLE X. Surface Structures on High-Miller-Index (Stepped) Substrates (Continued)

Substrate	Adsorbate	Surface Structure	Reference
W(S)-[6(110)×(1 $\bar{1}$ 0)]	O ₂	(2×1)-O	382
W(S)-[8(110)×(112)]	O ₂	(2×1)-O	382
W(S)-[10(110)×(011)]	O ₂	(2×1)-O	405
W(S)-[12(110)×(1 $\bar{1}$ 0)]	O ₂	(2×1)-O	382
W(S)-[13(001)×(1 $\bar{1}$ 0)]	H ₂	($\sqrt{2} \times \sqrt{2}$)R45°-H	945
		Incommensurate	945
		(1×1)-H	945
W(S)-[16(110)×(112)]	O ₂	(2×1)-O	382
W(S)-[24(110)×(011)]	O ₂	(2×1)-O	405
ZnO(40 $\bar{4}$ 1)	[clean]	Similar to 1×1	1239
ZnO(50 $\bar{5}$ 1)	[clean]	Similar to 1×1	1239

References for Tables I—X

1. K. Muller, *Zeits. Naturforschung* 20A, 153 (1965).
2. A. U. MacRae, *Surface Sci.* 1, 319 (1964).
3. L. H. Germer, E. J. Schneiber and C. D. Hartman, *Phil. Mag.* 5, 222 (1960).
4. R. L. Park and H. E. Farnsworth, *Appl. Phys. Letters* 3, 167 (1963).
5. T. Edmonds and R. C. Pitkethly, *Surface Sci.* 15, 137 (1969).
6. A. U. MacRae, *Science* 139, 379 (1963).
7. G. Ertl, *Surface Sci.* 6, 208 (1967).
8. N. Takahashi et al., *C. R. Acad. Sci.* 269 B, 618 (1969).
9. G. W. Simmons, D. F. Mitchell and K. R. Lawless, *Surface Sci.* 8, 130 (1967).
10. C. W. Tucker, Jr., *Surface Sci.* 2, 516 (1964).
11. C. W. Tucker, Jr., *J. Appl. Phys.* 35, 1897 (1964).
12. J. T. Grant and T. W. Haas, *Surface Sci.* 21, 76 (1970).
13. W. P. Ellis, *J. Chem. Phys.* 48, 5695 (1968).
14. J. Ferrante and G. C. Barton, NASA Tech. Note D-4735 (1968).
15. N. J. Taylor, *Surface Sci.* 2, 544 (1964).
16. J. B. Marsh and H. E. Farnsworth, *Surface Sci.* 1, 3 (1964).
17. R. E. Schlier and H. E. Farnsworth, *J. Chem. Phys.* 30, 917 (1959).
18. H. E. Farnsworth, R. E. Schlier, T. H. George and R. M. Buerger, *J. Appl. Phys.* 29, 1150 (1958).
19. J. J. Lander and J. Morrison, *J. Appl. Phys.* 34, 1411 (1963).
20. J. J. Lander and J. Morrison, *J. Appl. Phys.* 33, 2089 (1962).
21. G. Rovida et al., *Surface Sci.* 14, 93 (1969).
22. R. O. Adams, *The Structure and Chemistry of Solid Surfaces*, ed. G. A. Somorjai, John Wiley and Sons, Inc., New York (1969).
23. H. E. Farnsworth and D. M. Zehner, *Surface Sci.* 17, 7 (1969).
24. G. J. Dooley and T. W. Haas, *Surface Sci.* 19, 1 (1970).
25. B. D. Campbell, C. A. Haque and H. E. Farnsworth, *The Structure and Chemistry of Solid Surfaces*, ed. G. A. Somorjai, John Wiley and Sons, Inc., New York, 1969.
26. G. Ertl, *Surface Sci.* 7, 309 (1977).
27. T. Edmonds and R. C. Pitkethly, *Surface Sci.* 17, 450 (1969).
28. A. E. Morgan and G. A. Somorjai, *J. Chem. Phys.* 51, 3309 (1969).
29. J. C. Bertolini and G. Dalmai-Imelik, Coll. Intern. CNRS, Paris, 7-11 July 1969.
30. J. J. Lander and J. Morrison, *Surface Sci.* 4, 241 (1966).
31. L. H. Germer and A. U. MacRae, *J. Chem. Phys.* 36, 1555 (1962).
32. A. J. van Bommel and F. Meyer, *Surface Sci.* 8, 381 (1967).
33. J. J. Lander and J. Morrison, *J. Chem. Phys.* 37, 729 (1962).
34. R. Heckingbottom, *The Structure and Chemistry of Solid Surfaces*, ed. G. A. Somorjai, John Wiley and Sons, Inc., New York (1969).
35. J. L. Domange and J. Oudar, *Surface Sci.* 11, 124 (1968).
36. M. Perdureau and J. Oudar, *Surface Sci.* 20, 80 (1970).
37. A. J. van Bommel and F. Meyer, *Surface Sci.* 6, 391 (1967).
38. J. V. Florio and W. D. Robertson, *Surface Sci.* 18, 398 (1969).
39. J. C. Bertolini and G. Dalmai-Imelik, Rapport Inst. de Rech. sur la Catalyse, Villeurbanne (1969).
40. D. L. Smith and R. F. Merrill, *J. Chem. Phys.* 52, 5861 (1970).
41. M. Boudart and D. F. Ollis, *The Structure and Chemistry of Solid Surfaces*, ed., G. A. Somorjai, John Wiley and Sons, Inc., New York (1969).
42. F. Jona, *J. Phys. Chem. Solids* 28, 2155 (1967).
43. S. M. Bedair, F. Hoffmann and H. P. Smith, Jr., *J. Appl. Phys.* 39, 4026 (1968).
44. H. H. Farrell, Ph.D. Dissertation, University of California, Berkeley (1969).
45. L. K. Jordan and E. J. Scheibner, *Surface Sci.* 10, 373 (1968).
46. L. Trepte, C. Menzel-Kopp and E. Mensel, *Surface Sci.* 8, 223 (1967).
47. R. N. Lee and H. E. Farnsworth, *Surface Sci.* 3, 461 (1965).
48. J. T. Grant, *Surface Sci.* 18, 228 (1969).
49. R. E. Schlier and H. E. Farnsworth, *J. Appl. Phys.* 25, 1333 (1954).

50. H. E. Farnsworth and J. Tuul, *J. Phys. Chem. Solids* 9, 48 (1958).
51. J. W. May and L. H. Germer, *Surface Sci.* 11, 443 (1968).
52. R. E. Schlier and H. E. Farnsworth, *Advances Catalysis* 9, 434 (1957).
53. L. H. Germer and C. D. Hartman, *J. Appl. Phys.* 31, 2085 (1960).
54. H. E. Farnsworth and H. H. Madden, Jr., *J. Appl. Phys.* 32, 1933 (1961).
55. R. L. Park and H. E. Farnsworth, *J. Chem. Phys.* 43, 2351 (1965).
56. L. H. Germer, *Advances Catalysis* 13, 191 (1962).
57. L. H. Germer, R. Stern and A. U. MacRae, *Metal Surfaces* ASM, Metals Park, Ohio, 1963, p. 287.
58. C. W. Tucker, Jr., *J. Appl. Phys.* 37, 3013 (1966).
59. C. A. Haque and H. E. Farnsworth, *Surface Sci.* 1, 378 (1964).
60. A. J. Pignocco and G. E. Pellissier, *J. Electrochem. Soc.* 112, 1188 (1965).
61. H. K. A. Kann and S. Feuerstein, *J. Chem. Phys.* 50, 3618 (1969).
62. K. Hayek and H. E. Farnsworth, *Surface Sci.* 10, 429 (1968).
63. H. E. Farnsworth and K. Hayek, *Suppl. Nuovo Cimento* 5, 2 (1967).
64. G. J. Dooley and T. W. Haas, *J. Chem. Phys.* 52, 461 (1970).
65. K. K. Vijai and P. F. Packman, *J. Chem. Phys.* 50, 1343 (1969).
66. P. J. Estrup, *The Structure and Chemistry of Solid Surfaces*, ed. G. A. Somorjai, John Wiley and Sons, Inc., New York, 1969.
67. J. Anderson and W. E. Danforth, *J. Franklin Inst.* 279, 160 (1965).
68. M. Onchi and H. E. Farnsworth, *Surface Sci.* 11, 203 (1968).
69. R. A. Armstrong, *The Structure and Chemistry of Solid Surfaces*, ed. G. A. Somorjai, John Wiley and Sons, Inc., New York (1969).
70. J. C. Tracy and P. W. Palmberg, *J. Chem. Phys.* 51, 4852 (1969).
71. R. L. Park and H. H. Madden, *Surface Sci.* 11, 188 (1968).
72. A. E. Morgan and G. A. Somorjai, *Surface Sci.* 12, 405 (1968).
73. C. Burggraf and A. Mosser, *C. R. Acad. Sci.* 268 B, 1167 (1969).
74. A. E. Morgan and G. A. Somorjai, *Trans. Am. Cryst. Assoc.* 4, 59, (1968).
75. J. Anderson and P. J. Estrup, *J. Chem. Phys.* 46, 563 (1967).
76. M. Onchi and H. E. Farnsworth, *Surface Sci.* 13, 425 (1969).
77. G. J. Dooley and T. W. Haas, *J. Chem. Phys.* 52, 993 (1970).
78. P. W. Tamm and L. D. Schmidt, *J. Chem. Phys.* 51, 5352 (1969).
79. P. J. Estrup and J. Anderson, *J. Chem. Phys.* 45, 2254 (1966).
80. H. H. Madden and H. E. Farnsworth, *J. Chem. Phys.* 34, 1186 (1961).
81. J. W. May and L. H. Germer, *The Structure and Chemistry of Surface*, ed. G. A. Somorjai, John Wiley and Sons, Inc., New York (1969).
82. P. J. Estrup and J. Anderson, *J. Chem. Phys.* 46, 567 (1967).
83. T. L. Park and H. E. Farnsworth, *J. Appl. Phys.* 35, 2220 (1964).
84. P. J. Estrup and J. Anderson, *J. Chem. Phys.* 49, 523 (1968).
85. E. Margot et al., *C. R. Acad. Sci.* 270 C, 1261 (1970).
86. N. W. Wideswell and J. M. Ballingal, *J. Vac. Sci. Techn.* 7, 496 (1970).
87. F. Portele, *Zeits. Naturforschung* 24A, 1268 (1969).
88. G. Dalmai-Imelik and J. C. Bertolini, *C. R. Acad. Sci.* 270, 1079 (1970).
89. L. H. Germer and A. U. MacRae, *J. Appl. Phys.* 33, 2923 (1962).
90. L. H. Germer, A. U. MacRae and A. Robert, *Welch Foundation Research Bull.* No. 11, 1961, p. 5.
91. R. L. Park and H. E. Farnsworth, *J. Chem. Phys.* 40, 2354 (1964).
92. L. H. Germer, J. W. May and R. J. Szostak, *Surface Sci.* 7, 430 (1967).
93. J. W. May, L. H. Germer and C. C. Chang, *J. Chem. Phys.* 45, 2383 (1966).
94. A. G. Jackson and M. P. Hooker, *Surface Sci.* 6, 297 (1967).
95. G. Ertl and P. Rau, *Surface Sci.* 15, 443 (1969).
96. C. W. Tucker, Jr., *J. Appl. Phys.* 38, 2696 (1967).
97. C. W. Tucker, Jr., *J. Appl. Phys.* 37, 4147 (1966).
98. A. J. Pignocco and G. E. Pellissier, *Surface Sci.* 7, 261 (1967).
99. K. Moliere and F. Portele, *The Structure and Chemistry of Solid Surfaces*, ed. G. A. Somorjai, John Wiley and Sons, Inc., N. Y. (1969).
100. T. W. Haas and A. G. Jackson, *J. Chem. Phys.* 44, 2921 (1966).
101. T. W. Haas, A. G. Jackson and M. P. Hooker, *J. Chem. Phys.* 46, 3025 (1967).
102. T. W. Haas, *The Structure and Chemistry of Solid Surfaces*, ed. G. A. Somorjai, John Wiley and Sons, Inc., N. Y. 1969.

103. L. H. Germer, *Physics Today*, July 1964, p. 19.
104. L. H. Germer and J. W. May, *Surface Sci.* 4, 452 (1966).
105. G. J. Dooley and T. W. Haas, *J. Vac. Sci. Techn.* 7, 49 (1970).
106. C. C. Chang and L. H. Germer, *Surface Sci.* 8, 115 (1967).
107. T. C. Tracy and J. M. Blakeley, *The Structure and Chemistry of Solid Surfaces*, ed. G. A. Somorjai, John Wiley and Sons, Inc., N. Y. (1969).
108. C. C. Chang, *J. Electrochem. Soc.* 115, 354 (1968).
109. J. W. May and L. H. Germer, *J. Chem. Phys.* 44, 2895 (1966).
110. L. H. Germer and A. U. MacRae, *Proc. Natl. Acad. Sci. U.S.* 48, 997 (1962).
111. T. W. Haas, *J. Appl. Phys.* 39, 5854 (1968).
112. D. L. Adams et al., *Surface Sci.* 22, 45 (1970).
113. J. W. May, R. J. Szostak and L. H. Germer, *Surface Sci.* 15, 37 (1969).
114. D. H. Buckley, NASA Techn. Note D-5689, 1970.
115. I. Marklund, S. Andersson and J. Martinsson, *Arkiv for Fysik* 37, 127 (1968).
116. P. Legare and G. Marie, *J. Chim. Phys. Physicochim. Biol.* 68(7-8), 120 (1971).
117. G. Marie, J. R. Anderson, and B. B. Johnson, *Proc. Roy. Soc. Lond. A*, 320, 227 (1970).
118. T. Edmonds, J. J. McCarroll and R. C. Pitkethly, *J. Vac. Sci. Tech.* 8(1) 68 (1971).
119. K. Okado, T. Halsushika, H. Tomita, S. Motov and N. Takalashi, *Shinku* 13 (11), 371 (1970).
120. B. Lang, R. W. Joyner, and G. A. Somorjai, *Surf. Sci.* 30, 454 (1972).
121. M. Henzler, and J. Topler, *Surf. Sci.* 40, 388 (1973).
122. H. Van Hove, R. Leysen, *Phys. Status Solidi A* 9(1), 361 (1972).
123. S. M. Bedair and H. P. Smith, Jr., *J. Appl. Phys.* 42, 3616 (1971).
124. J. T. Grant, *Surface Sci.* 25, 451 (1971).
125. R. W. Joyner, C. S. McKee and M. W. Roberts, *Surface Sci.* 26, 303 (1971).
126. J. C. Tracy, *J. Chem. Phys.* 56(6), 2748 (1971).
127. M. A. Chester, and J. Pritchard, *Surface Sci.* 28, 460 (1971).
128. R. W. Joyner, C. S. McKee and M. W. Roberts, *Surface Sci.* 27, 279 (1971).
129. J. C. Tracy, *J. Chem. Phys.* 56(6), 2736 (1971).
130. D. Tabor and J. M. Wilson, *J. Cryst. Growth* 9, 60 (1971).
131. D. L. Adams and L. H. Germer, *Surface Sci.* 27, 21 (1971).
132. J. Perdureau and G. E. Rhead, *Surface Sci.* 24, 555 (1971).
133. P. W. Palmberg, *Surface Sci.* 25, 104 (1971).
134. G. Ertl and J. Koppers, *Surface Sci.* 24, 104 (1971).
135. R. Heckingbottom and P. R. Wood, *Surface Sci.* 23, 437 (1970).
136. K. J. Matysik, *Surface Sci.* 29, 324 (1972).
137. G. E. Becker and H. D. Hagstrum, *Surface Sci.* 30, 505 (1972).
138. D. L. Adams and L. H. Germer, *Surface Sci.* 32, 205 (1972).
139. H. P. Bonzel and R. Ku, *Surface Sci.* 33, 91 (1972).
140. P. Michel and Ch. Jardin, *Surface Sci.* 36, 478 (1973).
141. A. Melmed and J. J. Carroll, *J. Vac. Sci. Technol.* 10, 164 (1973).
142. H. D. Hagstrum and G. E. Becker, *Phys. Rev. Lett.* 22, 1054 (1969); *J. Chem. Phys.* 54, 1015 (1971).
143. W. H. Weinberg and R. P. Merrill, *Surface Sci.* 32, 317 (1972).
144. P. B. Sewell, D. F. Mitchell and M. Cohen, *Surface Sci.* 33, 535 (1972).
145. F. Forstmann, W. Berndt and P. Buttner, *Phys. Rev. Lett.* 30, 17 (1973).
146. H.A. Engelhardt and D. Menzel, *Surface Sci.* 57, 591 (1976).
147. H. Albers, W. J. J. VanderWal and G. A. Bootsma, *Surface Sci.* 68, 47 (1977).
148. G. Rovida, F. Pratesi, M. Maglietta and E. Ferroni, *Surface Sci.* 43, 230 (1974).
149. W. Berndt, *Proc 2nd International Conference on Solid Surfaces* 653 (1974).
150. F. Forstmann, *Proc 2nd International Conference on Solid Surfaces* 657 (1974).
151. P. J. Goddard and R. M. Lambert, *Surface Sci.* 67, 180 (1977).
152. Y. Tu and J. M. Blakely, *Journal of Vacuum Science Technology* 15, 563 (1978).
153. G. Rovida, F. Pratesi, M. Maglietta and E. Ferroni *Proc 2nd International Conference on Solid Surfaces*, 117 (1974).
154. G. Rovida and F. Pratesi, *Surface Sci.* 51, 270 (1975).
155. P. J. Goddard, K. Schwaha and R. M. Lambert, *Surface Sci.* 71, 351 (1978).
156. R. H. Roberts and J. Pritchard, *Surface Sci.* 54, 687 (1976).
157. N. Stone, M. A. VanHove, S. Y. Tong and M. B. Webb, *Physical Review Letter* 40, 273 (1978).

158. G. McElhiney, H. Papp and J. Pritchard, *Surface Sci.* 54, 617 (1976).
159. M. A. Chesters, M. Hussain and J. Pritchard, *Surface Sci.* 35, 161 (1973).
160. P. I. Cohen, J. Unguris and M. B. Webb, *Surface Sci.* 58, 429 (1976).
161. M. A. Chesters and G. A. Somorjai, *Surface Sci.* 52, 21 (1975).
162. D. M. Zehner and J. F. Wendelken, Proc. 7th Internal Vacuum Congress and 3rd International Conference on Solid Surfaces 517 (1977).
163. P. J. Goddard, J. West and R. M. Lambert, *Surface Sci.* 71, 447 (1978).
164. P. G. Lurie and J. M. Wilson, *Surface Sci.* 65, 453 (1977).
165. J. Suzanne, J. P. Coulomb and M. Bienfait, *Surface Sci.* 40, 414 (1973).
166. M. D. Chinn and S. C. Fain, Jr., *Journal of Vacuum Science Technology* 14, 314 (1977).
167. H. M. Kramer and J. Suzanne, *Surface Sci.* 54, 659 (1976).
168. M. E. Bridge, C. M. Comrie and R. M. Lambert, *Surface Sci.* 67, 393 (1977).
169. C. Jardin and P. Michel, *Surface Sci.* 71, 575 (1978).
170. F. H. P. M. Habraken, E. P. Kieffer and G. A. Bootsma, Proc 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces 877 (1977).
171. L. McDonnel and D. P. Woodruff, *Surface Sci.* 46, 505 (1974).
172. J. Kessler and F. Thieme, *Surface Sci.* 67, 405 (1977).
173. C. Benndorf, K. H. Gressman and F. Thieme, *Surface Sci.* 61, 646, (1976).
174. M. D. Chinn and S. C. Fain, Jr., *Physical Review Letters* 39, 146 (1977).
175. S. Nakanishi and T. Horiguchi, Proc. 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces, A2727 (1977).
176. M. Grunze, F. Bozso, G. Ertl and M. Weiss, *Applications of Surface Science* 1, 241 (1978).
177. F. Bozso, G. Ertl, M. Grunze and M. Weiss, *Applications of Surface Science* 1, 103 (1978).
178. B. Z. Olshanetsky, S. M. Repinsky and A. A. Shklyayev, *Surface Sci.* 64, 224 (1977).
179. S. Sinharoy and M. Henzler, *Surface Sci.* 51, 75 (1975).
180. V. P. Ivanov, G. K. Boreshov, V. I. Savchenko, W. F. Egelhoff, Jr. and W. H. Weinberg, *Journal of Catalysis* 48, 269 (1977).
181. H. Conrad, J. Koppers, F. Nitschke and A. Plagge, *Surface Sci.* 69, 668 (1977).
182. D. I. Hagen, B. E. Nieuwenhuys, G. Rovida and G. A. Somorjai, *Surface Sci.* 57, 632 (1976).
183. J. Koppers and A. Plagge, *Journal of Vacuum Science Technology* 13, 259 (1976).
184. V. P. Ivanov, G. K. Boreshov, V. I. Savchenko, W. F. Egelhoff, Jr. and W. H. Weinberg, *Surface Sci.* 61, 207 (1976).
185. C. M. Comrie and W. H. Weinberg, *Journal of Vacuum Science Technology* 13, 264 (1976).
186. C. M. Comrie and W. H. Weinberg, *J. Chem. Phys.* 64, 250 (1976).
187. B. E. Nieuwenhuys, D. I. Hagen, G. Rovida and G. A. Somorjai, *Surface Sci.* 59, 155 (1976).
188. J. Kanski and T. N. Rhodin, *Surface Sci.* 65, 63 (1977).
189. L. J. Clark, Proc 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces, A2725 (1977).
190. H. M. Kennett and A. E. Lee, *Surface Sci.* 48, 606 (1975).
191. J. M. Wilson, *Surface Sci.* 59, 315 (1976).
192. R. Pantel, M. Bujor and J. Bardolle, *Surface Sci.* 62, 739 (1977).
193. H. Conrad, G. Ertl, J. Koppers and E. E. Latta, *Surface Sci.* 50, 296 (1975).
194. P. H. Holloway and J. B. Hudson, *Surface Sci.* 43, 141 (1974).
195. H. Conrad, G. Ertl, J. Koppers and E. E. Latta, *Surface Sci.* 57, 475 (1976).
196. W. Erley, K. Besoche and H. Wagner, *J. Chem. Phys.* 66, 5269 (1977).
197. P.M. Marcus, J.E. Demuth and D.W. Jepsen, *Surface Sci.* 53, 501 (1975).
198. J. E. Demuth, and T. N. Rhodin, *Surface Sci.* 45, 249 (1974).
199. G. Ertl, *Surface Sci.* 47, 86 (1975).
200. K. Christmann, O. Schober and G. Ertl, *J. Chem. Phys.* 60, 4719 (1974).
201. M. A. Van Hove, G. Ertl, W. H. Weinberg, K. Christmann and H.J. Behm, Proc 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces, 2415 (1977).
202. H. Conrad, G. Ertl, J. Koppers and E. E. Latta, *Surface Sci.* 58, 578 (1976).
203. K. Christmann, O. Schober, G. Ertl and M. Neumann, *J. Chem. Phys.* 60, 4528 (1974).
204. G. Casalone, M. G. Cattania, M. Simonetta and M. Tescari, *Surface Sci.* 72, 739 (1978).
205. J. E. Demuth, D. W. Jepsen and P. M. Marcus, *Phys. Rev. Lett.* 32, 1182 (1974).
206. W. Erley and H. Wagner, *Surface Sci.* 66, 371 (1977).
207. H. Conrad, G. Ertl, J. Koppers and E. E. Latta, *Surface Sci.* 65, 245 (1977).

208. H. Conrad, G. Ertl, J. Küppers and E. E. Latta, *Surface Sci.* 65, 235 (1977).
209. H. Conrad, G. Ertl, J. Koch and E. E. Latta, *Surface Sci.* 43, 462 (1974).
210. A. M. Bradshaw and F. M. Hoffman, *Surface Sci.* 72, 513 (1978).
211. K. Christmann, G. Ertl and O. Schöber, *Surface Sci.* 40, 61 (1973).
212. H. Conrad, G. Ertl and E. E. Latta, *Surface Sci.* 41, 435 (1974).
213. H. P. Bonzel and R. Ku, *Surface Sci.* 40, 85 (1973).
214. B. Carrière, J. P. Deville, G. Maire and P. Lègaré, *Sci.* 58, 578 (1976).
215. P. Lègaré, G. Maire, B. Carrière and J. P. Deville, *Surface Sci.* 68, 348 (1977).
216. J. A. Joebstl, *Journal of Vacuum Science Technology* 12, 347 (1975).
217. W. H. Weinberg, D. R. Monroe, V. Lampton and R. P. Merrill, *Journal of Vacuum Science Technology* 14, 444 (1977).
218. G. Ertl, M. Neumann and K. M. Streit, *Surface Sci.* 64, 393 (1977).
219. S. L. Bernasek and G. A. Somorjai, *J. Chem. Phys.* 60, 4552 (1974).
220. K. Christmann, G. Ertl and T. Pignet, *Surface Sci.* 54, 365 (1976).
221. K. Baron, D. W. Blakely and G. A. Somorjai, *Surface Sci.* 41, 45 (1974).
222. C. M. Comrie, W. H. Weinberg and R. M. Lambert, *Surface Sci.* 57, 619 (1976).
223. L. E. Firment and G. A. Somorjai, *J. Chem. Phys.* 63, 1037 (1975).
224. L. E. Firment and G. A. Somorjai, *Surface Sci.* 55, 413 (1976).
225. W. Heegemann, E. Bechtold and K. Hayek, Proc 2nd International Conference on Solid Surfaces, 185 (1974).
226. W. Heegemann, K. H. Meister, E. Bechtold and K. Hayek, *Surface Sci.* 49, 161 (1975).
227. Y. Berthier, M. Perdureau and J. Oudar, *Surface Sci.* 44, 281 (1974).
228. K. Schwaka and E. Bechtold, *Surface Sci.* 66, 383 (1977).
229. D. A. Gorodetsky and A. N. Knysh, *Surface Sci.* 40, 651 (1973).
230. M. Housley, R. Ducros, G. Piquard and A. Cassuto, *Surface Sci.* 68, 277 (1977).
231. D. G. Castner, B. A. Sexton and G. A. Somorjai, *Surface Sci.* 71, 519 (1978).
232. T. E. Madey, H. A. Engelhardt and D. Menzel, *Surface Sci.* 48, 304 (1975).
233. T. E. Madey and D. Menzel, Proc 2nd International Conference on Solid Surfaces, 229 (1974).
234. L. R. Danielson, M. J. Dresser, E. E. Donaldson and J. T. Dickinson, *Surface Sci.* 71, 599 (1978).
235. L. R. Danielson, M. J. Dresser, E. E. Donaldson and D. R. Sandstrom, *Surface Sci.* 71, 615 (1978).
236. K. C. Pandey, T. Sakurai and H. D. Hagstrum, *Phys. Rev. B* 16, 3648 (1977).
237. H. Ibach and J. E. Rowe, *Surface Sci.* 43, 481 (1974).
238. R. Heckingbottom and P. R. Wood, *Surface Sci.* 36, 594 (1973).
239. A. J. van Bommel and J. E. Crombeen, *Surface Sci.* 36, 773 (1973).
240. H. D. Shih, F. Jona, D. W. Jepsen and P. M. Marcus, *Journal of Vacuum Science Technology* 15, 596 (1978).
241. H. D. Shih, F. Jona, D. W. Jepsen and P. M. Marcus, *Physical Review Letters* 36, 798 (1976).
242. H. D. Shih, F. Jona, D. W. Jepsen and P. M. Marcus, *Surface Sci.* 60, 445 (1976).
243. R. Bastasz, C. A. Colmenares, R. L. Smith and G. A. Somorjai, *Surface Sci.* 67, 45 (1977).
244. T. E. Madey, J. J. Czyzewski and J. T. Yates, Jr., *Surface Sci.* 57, 580 (1976).
245. W. N. Unertl and J. M. Blakely, *Surface Sci.* 69, 23 (1977).
246. A. Oustry, L. Lafourcade and A. Escaut, *Surface Sci.* 40, 545 (1973).
247. Y. Berthier, M. Perdureau and J. Oudar, *Surface Sci.* 36, 225 (1973).
248. J. C. Fuggle, E. Umbach, P. Feulner and D. Menzel, *Surface Sci.* 64, 69 (1977).
249. E. Zanazzi, F. Jona, D. W. Jepsen and P. M. Marcus, *Phys. Rev. B* 14, 432 (1976).
250. A. Ignatiev, F. Jona, D. W. Jepsen and P. M. Marcus, *Surface Sci.* 40, 439 (1973).
251. M. Kostelitz, J. L. Domange and J. Oudar, *Surface Sci.* 34, 431 (1973).
252. G. McElhiney and J. Pritchard, *Surface Sci.* 60, 397 (1976).
253. M. Maglietta and G. Rovida, *Surface Sci.* 71, 495 (1978).
254. G. Rovida and M. Maglietta, Proc. 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces 963 (1977).
255. K. Horn, M. Hussain and J. Pritchard, *Surface Sci.* 63, 244 (1977).
256. S. Ekelund and C. Leygraf, *Surface Sci.* 40, 179 (1973).
257. L. McDonnell, D. P. Woodruff and K. A. R. Mitchell, *Surface Sci.* 45, 1 (1974).
258. G. G. Tibbetts, J. M. Burkstrand and J. C. Tracy, *Phys. Rev. B* 15, 3652 (1977).
259. E. Legrand-Bonnyns and A. Ponslet, *Surface Sci.* 53, 675 (1975).
260. G. G. Tibbetts, J. M. Burkstrand and J. C. Tracy, *Journal of Vacuum Science Technology* 13, 362 (1976).

261. E. G. McRae and C. W. Caldwell, *Surface Sci.* 57, 77 (1976).
262. J. R. Noonan, D. M. Zehner and L. H. Jenkins, *Surface Sci.* 69, 731 (1977).
263. P. Hoffmann, R. Unwin, W. Wyrobisch and A. M. Bradshaw, *Surface Sci.* 72, 635 (1978).
264. U. Gerhardt and G. Franz-Moller, Proc. 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces 897 (1977).
265. C. R. Brundle and K. Wandelt, Proc. 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces, 1171 (1977).
266. J. M. Burkstrand, G. G. Kleiman, G. G. Tibbetts and J. C. Tracy, *Journal of Vacuum Science Technology* 13, 291 (1976).
267. A. Salwen and J. Rundgren, *Surface Sci.* 53, 523 (1975).
268. K. O. Legg, F. Jona, D. W. Jepsen and P. M. Marcus, *Physical Review B* 16, 5271 (1977).
269. C. Leygraf and S. Ekelund, *Surface Sci.* 40, 609 (1973).
270. G. W. Simmons and D. J. Dwyer, *Surface Sci.* 48, 373 (1975).
271. C. F. Brucker and T. N. Rhodin, *Surface Sci.* 57, 523 (1976).
272. T. Horiguchi and S. Nakanishi, Proc. 2nd International Conference on Solid Surfaces, 89 (1974).
273. M. Watanabe, M. Miyamura, T. Matsudaira and M. Onchi, Proc. 2nd International Conference on Solid Surfaces, 501 (1974).
274. C. Brucker and T. Rhodin, *Journal of Catalysis* 47, 214 (1977).
275. F. Jona, K. O. Legg, H. D. Shih, D. W. Jepsen and P. M. Marcus, *Physical Review Letters* 40, 1466 (1978).
276. T. Matsudaira, M. Watanabe and M. Onchi, Proc. 2nd International Conference on Solid Surfaces, 181 (1974).
277. K. O. Legg, F. Jona, D. W. Jepsen and P. M. Marcus, *Surface Sci.* 66, 25 (1977).
278. D. J. Dwyer and G. W. Simmons, *Surface Sci.* 64, 617 (1977).
279. C. Leygraf, G. Hultquist and S. Ekelund, *Surface Sci.* 51, 409 (1975).
280. C. Leygraf and G. Hultquist, *Surface Sci.* 61, 69 (1976).
281. T. N. Rhodin and G. Broden, *Surface Sci.* 60, 466 (1976).
282. G. Broden and T. N. Rhodin, *S. S. Comm* 18, 105 (1976).
283. A. Ignatiev, T. N. Rhodin and S. Y. Tong, *Surface Sci.* 42, 37 (1974).
284. R. Riwan, C. Guillot and J. Paigne, *Surface Sci.* 47, 183 (1975).
285. J. Lecante, R. Riwan and G. Guillot, *Surface Sci.* 35, 271 (1973).
286. C. Guillot, R. Riwan and J. Lecante, *Surface Sci.* 59, 581 (1976).
287. A. Ignatiev, F. Jona, D. W. Jepsen and P. M. Marcus, *Surface Sci.* 49, 189 (1975).
288. J. M. Wilson, *Surface Sci.* 53, 330 (1975).
289. A. Glachant, J. P. Coulomb and J. P. Biberian, *Surface Sci.* 59, 619 (1976).
290. H. H. Farrell and M. Strongin, *Surface Sci.* 38, 18 (1973).
291. H. H. Brongersma and J. B. Theeten, *Surface Sci.* 54, 519 (1976).
292. Y. Murata, S. Ohtani and K. Terada, Proc. 2nd International Conference on Solid Surfaces, 837 (1974).
293. J. E. Demuth, D. W. Jepsen and P. M. Marcus, *Journal of Vacuum Science Technology* 11, 190 (1974).
294. T. N. Rhodin and J. E. Demuth, Proc. 2nd International Conference on Solid Surfaces, 167 (1974).
295. S. Andersson, B. Kasemo, J. B. Pendry and M. A. VanHove, *Phys. Rev. Lett.* 31, 595 (1973).
296. E. G. McRae and C. W. Caldwell, *Surface Sci.* 57, 63 (1976).
297. P. H. Holloway and J. B. Hudson, *Surface Sci.* 43, 123 (1974).
298. G. Dalmai-Imelik, J. C. Bertolini and J. Rousseau, *Surface Sci.* 63, 67 (1977).
299. D. F. Mitchell, P. B. Sewell and M. Cohen, *Surface Sci.* 61, 355 (1976).
300. S. Andersson and J. B. Pendry, *Surface Sci.* 71, 75 (1978).
301. S. Andersson, Proc. 3rd International Vacuum Congress and 7th International Conference on Solid Surfaces, 1019 (1977).
302. K. Horn, A. M. Bradshaw and K. Jacobi, *Surface Sci.* 72, 719 (1978).
303. J. E. Demuth, D. W. Jepsen and P. M. Marcus, *Surface Sci.* 45, 733 (1974).
304. T. Matsudaira, M. Nishijima and M. Onchi, *Surface Sci.* 61, 651 (1976).
305. H. Froitzheim and H. D. Hagstrum, *Journal of Vacuum Science Technology* 15, 485 (1978).
306. G. E. Becker and H. D. Hagstrum, *Journal of Vacuum Science Technology* 11, 234 (1974).
307. J. M. Rickard, M. Perdureau and L. G. Dufour, Proc. 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces, 847 (1977).

308. A. Steinbrunn, P. Dumas and J. C. Colson, *Surface Sci.* 74, 201 (1978).
309. F. P. Netzer and M. Prutton, *Surface Sci.* 52, 505 (1975).
310. C. A. Pagageorgopoulos and J. M. Chen, *Surface Sci.* 52, 40 (1975).
311. P. W. Palmberg, *Surface Sci.* 25, 104 (1971).
312. C. R. Helms, H. P. Bonzel and S. Kelemen, *J. Chem. Phys.* 65, 1773 (1976).
313. B. Lang, P. Légaré and G. Maire, *Surface Sci.* 47, 89 (1975).
314. G. Kneringer and F. P. Netzer, *Surface Sci.* 49, 125 (1975).
315. G. Pirug, G. Brodén and H. P. Bonzel, Proc. 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces 907 (1977).
316. G. Brodén, G. Pirug and H. P. Bonzel, *Surface Sci.* 72, 45 (1978).
317. F. P. Netzer and G. Kneringer, *Surface Sci.* 51, 526 (1975).
318. H. P. Bonzel and G. Pirug, *Surface Sci.* 62, 45 (1977).
319. H. P. Bonzel, G. Brodén and G. Pirug, *Journal of Catalysis* 53, 96 (1978).
320. T. E. Fischer and S. R. Kelemen, *Surface Sci.* 69, 1 (1977).
321. T. E. Fischer and S. R. Kelemen, *Journal of Vacuum Science Technology* 15, 607 (1978).
322. S. J. White and D. P. Woodruff, *Surface Sci.* 63, 254 (1977).
323. S. J. White, D. P. Woodruff, B. W. Holland and R. S. Zimmer, *Surface Sci.* 74, 34 (1978).
324. S. J. White, D. P. Woodruff, B. W. Holland and R. S. Zimmer, *Surface Sci.* 68, 457 (1977).
325. T. Sakurai and H. D. Hagstrum, *Phys. Rev. B* 14, 1593 (1976).
326. J. J. Lander and J. Morrison, *J. Chem. Phys.* 37, 729 (1962).
327. A. P. Janssen and R. C. Schoonmaker, *Surface Sci.* 55, 109 (1976).
328. M. A. Chesters, B. J. Hopkins and M. R. Leggett, *Surface Sci.* 43, 1 (1974).
329. T. N. Taylor, C. A. Colmenares, R. L. Smith and G. A. Somorjai, *Surface Sci.* 54, 317 (1976).
330. B. J. Hopkins, G. D. Watts and A. R. Jones, *Surface Sci.* 52, 715 (1975).
331. C. A. Papageorgopoulos and J. M. Chen, *Surface Sci.* 39, 313 (1973).
332. A. M. Bradshaw, D. Menzel and M. Steinkilberg, Proc. 2nd International Conference on Solid Surfaces, 841 (1974).
333. E. Bauer, H. Poppa and Y. Viswanath, *Surface Sci.* 58, 578 (1976).
334. S. Prigge, H. Niehus and E. Bauer, *Surface Sci.* 65, 141 (1977).
335. J. L. Desplat, Proc. 2nd International Conference on Solid Surfaces 177 (1974).
336. P. E. Luscher and F. M. Propst, *Journal of Vacuum Science Technology* 14, 400 (1977).
337. R. Jaeger and D. Menzel, *Surface Sci.* 63, 232 (1977).
338. B. J. Hopkins, A. R. Jones and R. I. Winton, *Surface Sci.* 57, 266 (1976).
339. S. Usami and T. Nakagima, Proc. 2nd International Conference on Solid Surfaces, 237 (1974).
340. J. E. Demuth, D. W. Jepsen and P. M. Marcus, *Phys. Rev. Lett* 31, 540 (1973).
341. H. A. Engelhardt, A. M. Bradshaw and D. Menzel, *Surface Sci.* 40, 410 (1973).
342. G. Rovida and F. Pratesi, *Surface Sci.* 52, 542 (1975).
343. W. Heiland, F. Iberl, E. Taglauer and D. Menzel, *Surface Sci.* 53, 383 (1975).
344. E. Zanazzi, M. Maglietta, U. Bardi, F. Jona, D. W. Jepsen and P. M. Marcus, Proc. 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces, 2447 (1977).
345. R. A. Marbrow and R. M. Lambert, *Surface Sci.* 61, 317 (1976).
346. G. Gafner and R. Feder, *Surface Sci.* 57, 37 (1976).
347. B. E. Nieuwenhuys and G. A. Somorjai, *Surface Sci.* 72, 8 (1978).
348. J. L. Taylor and W. H. Weinberg, *Journal of Vacuum Science Technology* 15, 590 (1978).
349. E. B. Bas, P. Hafner and S. Klauser, Proc. 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces 881 (1977).
350. T. Miura and Y. Tuzi, Proc. 2nd International Conference on Solid Surfaces, 85 (1974).
351. L. Peralta, Y. Berthier and J. Oudar, *Surface Sci.* 55, 199 (1976).
352. S. Andersson, J. B. Pendry and P. M. Echenique, *Surface Sci.* 65, 539 (1977).
353. J. Küppers, *Surface Sci.* 36, 53 (1973).
354. D. F. Mitchell, P. B. Sewell, Proc. 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces 963 (1977).
355. D. F. Mitchell, P. B. Sewell and M. Cohen, *Surface Sci.* 69, 310 (1977).
356. H. H. Madden, J. Küppers and G. Ertl, *J. Chem. Phys.* 58, 3401 (1973).
357. H. H. Madden and G. Ertl, *Surface Sci.* 35, 211 (1973).
358. H. H. Madden, J. Küppers and G. Ertl, *Journal of Vacuum Science Technology* 11, 190 (1974).
359. T. N. Taylor and P. J. Estrup, *Journal of Vacuum Science Technology* 10, 26 (1973).

360. T. N. Taylor and P. J. Estrup, *Journal of Vacuum Science Technology* 11, 244 (1974).
361. G. L. Price, B. A. Sexton and B. G. Baker, *Surface Science* 60, 506 (1976).
362. M. Wilf and P. T. Dawson, *Surface Sci.* 65, 399 (1977).
363. R. Ducros and R. P. Merrill, *Surface Sci.* 55, 227 (1976).
364. R. M. Lambert and C. M. Comrie, *Surface Sci.* 46, 61 (1974).
365. P. D. Reed and R. M. Lambert, *Surface Sci.* 57, 485 (1976).
366. R. M. Lambert, *Surface Sci.* 49, 325 (1975).
367. Y. Berthier, J. Oudar and M. Huber, *Surface Sci.* 65, 361 (1977).
368. H. P. Bonzel and R. Ku, *J. Chem. Phys.* 58, 4617 (1973).
369. R. A. Marbrow and R. M. Lambert, *Surface Sci.* 67, 489 (1977).
370. T. W. Orent and R.S. Hansen, *Surface Sci.* 67, 325 (1977).
371. R. Ku, N. A. Gjostein and H. P. Bonzel, *Surface Sci.* 64, 465 (1977).
372. P. D. Reed, C. M. Comrie and R. M. Lambert, *Surface Sci.* 59, 33 (1976).
373. P. D. Reed, C. M. Comrie and R. M. Lambert, *Surface Sci.* 72, 423 (1978).
374. P. D. Reed, C. M. Comrie and R. M. Lambert, *Surface Sci.* 64, 603 (1977).
375. T. Sakurai and H. D. Hagstrum, *Journal of Vacuum Science Technology* 13, 807 (1976).
376. W. J. Lo, Y. W. Chung and G. A. Somorjai, *Surface Sci.* 71, 199 (1978).
377. M. A. VanHove, S. Y. Tong and M. H. Elconin, *Surface Sci.* 64, 85 (1977).
378. G. C. Wang, T. M. Lu and M. G. Lagally, Proc. 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces, A2726 (1974).
379. J. M. Baker and D. E. Eastman, *Journal of Vacuum Science Technology* 10, 223 (1973).
380. J. C. Buchholz and M. G. Lagally, *Journal of Vacuum Science Technology* 11, 194 (1974).
381. J. C. Buchholz and M. G. Lagally, *Physical Rev. Lett.* 35, 442 (1975).
382. K. Besocke and S. Berger, Proc. 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces 893 (1977).
383. T. E. Madey and J. T. Yates, *Surface Sci.* 63, 203 (1977).
384. T. Engel, H. Niehus and E. Bauer, *Surface Sci.* 52, 237 (1975).
385. J. C. Buchholz, G. C. Wang and M. G. Lagally, *Surface Sci.* 49, 508 (1975).
386. M. A. VanHove and S. Y. Tong, *Physical Review Letters* 35, 1092 (1975).
387. E. Bauer and T. Engel, *Surface Sci.* 71, 695 (1978).
388. N. R. Avery, *Surface Sci.* 41, 533 (1974).
389. Ch. Steinbrüchel and R. Gomer, *Surface Sci.* 67, 21 (1977).
390. Ch. Steinbrüchel and R. Gomer, *Journal of Vacuum Science Technology* 14, 484 (1977).
391. N. R. Avery, *Surface Sci.* 43, 101 (1974).
392. W. Göpel, *Surface Sci.* 62, 165 (1977).
393. R. A. Marbrow and R. M. Lambert, *Surface Sci.* 71, 107 (1978).
394. H. Papp and J. Pritchard, *Surface Sci.* 53, 371 (1975).
395. R. E. Kirby, C. S. McKee and M. W. Roberts, *Surface Sci.* 55, 725 (1976).
396. G. Maire, P. Bernhardt, P. Lègaré and G. Lindauer, Proc. 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces, 861 (1977).
397. K. Schwaha and E. Bechtold, *Surface Sci.* 65, 277 (1977).
398. F. P. Netzer and R. A. Wille, *Journal of Catalysis* 51, 18 (1978).
399. F. P. Netzer and R. A. Wille, Proc. 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces, 927 (1977).
400. K. Christmann and G. Ertl, *Surface Sci.* 60, 365 (1976).
401. J. Gland, *Surface Sci.* 71, 327 (1978).
402. D. G. Castner and G. A. Somorjai, *Surface Sci.* 83, 60 (1979).
403. G. Ertl and M. Plancher, *Surface Sci.* 48, 364 (1975).
404. B. J. Hopkins and G. D. Watts, *Surface Sci.* 44, 237 (1974).
405. T. Engel, T. von dem Hagen and E. Bauer, *Surface Sci.* 62, 361 (1977).
406. E. Gillet, J. C. Chiarena and M. Gillet, *Surface Sci.* 67, 393 (1977).
407. M. E. Bridge, R. A. Marbrow and R. M. Lambert, *Surface Sci.* 57, 415 (1976).
408. J. C. Buchholz and G. A. Somorjai, *J. Chem. Phys.* 66, 573 (1977).
409. L. L. Atanasoska, J. C. Buchholz and G. A. Somorjai, *Surface Sci.* 72, 189 (1978).
410. G. Brodén, T. Rhodin and W. Capehart, *Surface Sci.* 61, 143 (1976).
411. C. A. Papageorgopoulos and J. M. Chen, *Surface Sci.* 39, 283 (1973).
412. D. E. Eastman and J. E. Denuth, Proc. 2nd International Conference on Solid Surfaces, 827 (1974).

413. J. E. Demuth, *Surface Sci.* 69, 365 (1977).
414. G. Dalmai-Imelik, J. C. Bertolini, J. Massardier, J. Rousseau and B. Imelik, Proc. 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces, 1179 (1977).
415. J. C. Bertolini, G. Dalmai-Imelik and J. Rousseau, *Surface Sci.* 67, 478 (1977).
416. C. Casalone, M. G. Cattania, M. Simonetta and M. Tescari, *Surface Sci.* 62, 321 (1977).
417. K. Horn, A. M. Bradshaw and K. Jacobi, *Journal of Vacuum Science Technology* 15, 575 (1978).
418. F. C. Schouter, E. W. Kaleveld and G. A. Bootsma, *Surface Science* 63, 460 (1977).
419. J. McCarty and R. J. Madix, *Journal of Catalysis* 38, 402 (1975).
420. J. G. McCarty and R. J. Madix, *Journal of Catalysis* 48, 422 (1977).
421. N. M. Abbas and R. J. Madix, *Surface Science* 62, 739 (1977).
422. G. Maire, J. R. Anderson and B. B. Johnson, *Proc. Roy. Soc. (London) A* 320, 227 (1970).
423. L. L. Kesmodel, R. C. Baetzold and G. A. Somorjai, *Surface Sci.* 66, 299 (1977).
424. P. C. Stair and G. A. Somorjai, *J. Chem. Phys.* 66, 573 (1977).
425. W. H. Weinberg, H. A. Deans and R. P. Merrill, *Surface Sci.* 41, 312 (1974).
426. B. Lang, *Surface Sci.* 53, 317 (1975).
427. L. E. Firmet and G. A. Somorjai, *J. Chem. Phys.* 66, 2901 (1977).
428. P. C. Stair and G. A. Somorjai, *J. Chem. Phys.* 67, 4361 (1977).
429. J. L. Gland and G. A. Somorjai, *Surface Sci.* 38, 157 (1973).
430. J. L. Gland and G. A. Somorjai, *Surface Sci.* 41, 387 (1974).
431. T. E. Fischer and S. R. Kelemen, *Surface Sci.* 69, 485 (1977).
432. T. E. Fischer, S. R. Kelemen and H. P. Bonzel, *Surface Sci.* 64, 85 (1977).
433. F. P. Netzer, *Surface Sci.* 52, 709 (1975).
434. M. E. Bridge and R. M. Lambert, *Journal of Catalysis* 46, 143 (1977).
435. M. E. Bridge and R. M. Lambert, *Surface Sci.* 63, 315 (1977).
436. R. Ducros, M. Housley, M. Alnot and A. Cassuto, *Surface Sci.* 71, 433 (1978).
437. Y. W. Chung, W. Siekhaus and G. A. Somorjai, *Surface Sci.* 58, 341 (1976).
438. J. P. Biberian and G. A. Somorjai, *J. Vac. Sci. and Techn.* 16, 2073 (1979).
439. J. W. Matthews and W. A. Jesser, *Acta Metal.* 15, 595 (1967).
440. J. W. Matthews, *Phil. Mag.* 13, 1207 (1966).
441. J. P. Biberian and G. E. Rhead, *J. Phys. F* 3, 675 (1973).
442. J. P. Biberian and M. Huber, *Surface Sci.* 55, 259 (1976).
443. A. K. Green, S. Prigge and E. Bauer, *Thin Solid Films* 52, 163 (1978).
444. J. P. Biberian, *Surface Sci.* 74, 437 (1978).
445. V. K. Medvedev, A. G. Nauvometts and A. G. Fedorus, *Sov. Phys. Solid State* 12, 301 (1970).
446. A. G. Naumovets and A. G. Fedorus, *JETP Lett.* 10, 6 (1969).
447. L. G. Feinstein and E. Blanc, *Surface Sci.* 18, 350 (1969).
448. T. Edmonds and J. J. McCarroll, *Surface Sci.* 24, 353 (1971).
449. I. Abbati, L. Braicovich, C. M. Bertoni, C. Calandra and F. Manghi, *Phys. Rev. Lett.* 40, 469 (1978).
450. J. Abbati and L. Braicovich, Proc. 7th Vac. Congr. and 3rd Intern. Conf. Solid Surfaces, 1117 (Vienna 1977).
451. A. J. Melmed and J. J. McCarroll, *Surface Sci.* 19, 243 (1970).
452. D. C. Hothersall, *Phil. Mag.* 15, 1023 (1967).
453. R. E. Thomas and G. A. Haas, *J. Appl. Phys.* 43, 4900 (1972).
454. S. Anderson and B. Kasemo, *Surface Sci.* 32, 78 (1972).
455. R. L. Gerlach and T. N. Rhodin, *Surface Sci.* 17, 32 (1969).
456. S. Anderson and J. B. Pendry, *J. Phys. C* 6, 601 (1973).
457. S. Anderson and U. Jostell, *Surface Sci.* 46, 625 (1974).
458. R. L. Gerlach and T. N. Rhodin, *The Structure and Chemistry of Solid Surfaces*, G. A. Somorjai (1968), p. 55.
459. S. Anderson and J. B. Pendry, *J. Phys. C* 5, L41 (1972).
460. R. L. Gerlach and T. N. Rhodin, *Surface Sci.* 10, 446 (1968).
461. S. Anderson and U. Jostell, *Solid State Comm.* 13, 829 (1973).
462. S. Anderson and U. Jostell, *Solid State Comm.* 13, 833 (1973).
463. C. A. Papageorgopoulos and J. M. Chen, *Surface Sci.* 52, 40 (1975).
464. C. A. Papageorgopoulos and J. M. Chen, *Surface Sci.* 52, 53 (1975).
465. L. G. Beinstein, E. Blanc and D. Dufayard, *Surface Sci.* 19, 269 (1970).
466. D. C. Jackson, T. E. Gallon and A. Chambers, *Surface Sci.* 36, 381 (1973).

467. J. J. Burton, C. R. Helms and R. S. Polizzotti, *Surface Sci.* 57, 425 (1976).
468. J. J. Burton, C. R. Helms and R. S. Polizzotti, *J. Chem. Phys.* 65, 1089 (1976).
469. J. J. Burton, C. R. Helms and R. S. Polizzotti, *J. Vac. Sci. Technol.* 13, 204 (1976).
470. J. R. Wolfe and H. W. Weart, *The Structure and Chemistry of Solid Surfaces*, G. A. Somorjai (1968), p. 32.
471. J. Perdereau and I. Szymerska, *Surface Sci.* 32, 247 (1972).
472. E. Alkhoury Nemen, R. C. Cinti and T. T. A. Nguyen, *Surface Sci.* 30, 697 (1972).
473. P. W. Palmberg and T. N. Rhodin, *J. Chem. Phys.* 49, 134 (1968).
474. U. Gradmann, W. Kümmerle and P. Tillmanns, *Thin Solid Films* 34, 249 (1976).
475. C. A. Haque and H. E. Farnsworth, *Surface Sci.* 4, 195 (1966).
476. U. Gradmann, *Surface Sci.* 13, 498 (1969).
477. E. Bauer, *Surface Sci.* 7, 351 (1967).
478. P. W. Palmberg and T. N. Rhodin, *J. of Appl. Phys.* 39, 2425 (1968).
479. Y. Fujinaga, *Surface Sci.* 64, 751 (1977).
480. J. Erlewein and S. Hofmann, *Surface Sci.* 68, 71 (1977).
481. J. Henrion and G. E. Rhead, *Surface Sci.* 29, 20 (1972).
482. A. Sepulveda and G. E. Rhead, *Surface Sci.* 66, 436 (1977).
483. C. Argile and G. E. Rhead, *Surface Sci.* 78, 115 (1978).
484. M. G. Barthes and G. E. Rhead, *Surface Sci.* 80, 421 (1979).
485. K. Reichelt and F. Müller, *J. of Crystal Growth* 21, 323 (1974).
486. F. Delamare and G. E. Rhead, *Surface Sci.* 35, 172 (1973).
487. F. Delamare and G. E. Rhead, *Surface Sci.* 35, 185 (1973).
488. P. J. Goddard, J. West and R. M. Lambert, *Surface Sci.* 71, 447 (1978).
489. R. A. Marbrow and R. M. Lambert, *Surface Sci.* 61, 329 (1976).
490. P. J. Goddard and R. M. Lambert, *Surface Sci.* 79, 93 (1979).
491. R. C. Newman, *Phil. Mag.* 2, 750 (1957).
492. E. Bauer, *Structure et Propriétés des Solides*, CNRS, Paris (1969).
493. R. E. Thomas and G. A. Haas, *J. Appl. Phys.* 43, 4900 (1972).
494. H. E. Farnsworth, *Phys. Rev.* 40, 684 (1932).
495. J. Perdereau, J. P. Bibérian and G. E. Rhead, *J. Phys. F* 4, 798 (1974).
496. M. G. Barthes and G. E. Rhead, *Surface Sci.* 85, L211 (1979).
497. M. G. Barthes, Thesis University of Paris, 1978.
498. A. Sepulveda and G. E. Rhead, *Surface Sci.* 49, 669 (1975).
499. B. A. Hutchins, T. N. Rhodin and J. E. Demuth, *Surface Sci.* 54, 419 (1976).
500. J. O. Porteus, *Surface Sci.* 41, 515 (1974).
501. M. A. Van Hove, S. Y. Tong and N. Stoner, *Surface Sci.* 54, 259 (1976).
502. I. A. S. Edwards and H. R. Thirsk, *Surface Sci.* 39, 245 (1973).
503. C. Argile and G. E. Rhead, *Surface Sci.* 78, 125 (1978).
504. C. Argile, Thesis University of Paris, 1978.
505. A. G. Jackson and M. P. Hooker, *The Structure and Chemistry of Solid Surfaces*, G. A. Somorjai (1968), p. 73.
506. A. G. Elliot, *Surface Sci.* 51, 489 (1975).
507. J. P. Bibérian, *Surface Sci.* 59, 307 (1976).
508. T. W. Haas, A. G. Jackson and M. P. Hooker, *J. Appl. Phys.* 38, 4998 (1967).
509. A. G. Jackson, M. P. Hooker and T. W. Haas, *Surface Sci.* 10, 308 (1968).
510. J. H. Pollard and W. E. Danforth, *The Structure and Chemistry of Solid Surfaces*, G. A. Somorjai (1968), p. 71.
511. J. H. Pollard and W. E. Danforth, *J. Appl. Phys.* 39, 4019 (1968).
512. S. Thomas and T. W. Haas, *J. Vac. Sci. Technol.* 9, 840 (1972).
513. K. Hartig, A. P. Janssen and J. A. Venables, *Surface Sci.* 74, 69 (1978).
514. K. Hartig, Thesis Ruhr-Universität, Bochum.
515. A. G. Jackson and M. P. Hooker, *Surface Sci.* 28, 373 (1971).
516. A. G. Jackson and M. P. Hooker, *Surface Sci.* 27, 197 (1971).
517. D. A. Gorodetsky, Yu. P. Melnik and A. A. Yasko, *Ukr. Fiz. Zhurn.* 12, 649 (1967).
518. V. K. Medvedev and T. P. Smereka, *Sov. Phys. Solid State* 16, 1046 (1974).
519. A. G. Naumovets and A. G. Fedorus, *Sov. Phys. JETP* 41, 587 (1975).
520. V. K. Medvedev, A. G. Naumovets and T. P. Smereka, *Surface Sci.* 34, 368 (1973).

521. J. M. Chen and C. A. Papageorgopoulos, *Surface Sci.* 21, 377 (1970).
522. S. Thomas and T. W. Haas, *J. Vac. Sci. Technol.* 10, 218 (1973).
523. A. U. MacRae, K. Müller, J. J. Lander and J. Morrison, *Surface Sci.* 15, 483 (1969).
524. C. A. Papageorgopoulos and J. M. Chen, *Surface Sci.* 39, 283 (1973).
525. V. B. Voronin, A. G. Naumovets and A. G. Fedorus, *JETP Lett.* 15, 370 (1972).
526. C. S. Wang, *J. Appl. Phys.* 48, 1477 (1977).
527. A. G. Fedorus and A. G. Naumovets, *Surface Sci.* 21, 426 (1970).
528. A. G. Fedorus and A. G. Naumovets, *Sov. Phys. Solid State* 12, 301 (1970).
529. H. Niehus, Thesis Clausthal, 1975.
530. O. V. Kanash, A. G. Neumovets and A. G. Fedorus, *Sov. Phys. JETP* 40, 903 (1974).
531. D. A. Gorodetskii and Yu. P. Mel'nik, *Akad. Nauk SSSR* 33, 430 (1969).
532. D. A. Gorodetskii, Yu. P. Mel'nik, V. K. Sklyar and V. A. Usenko, *Surface Sci.* 85, L503 (1979).
533. D. A. Gorodetskii and Yu. P. Mel'nik, *Surface Sci.* 62, 647 (1977).
534. D. A. Gorodetskii, A. D. Gorchinskii, V. I. Maksimenko and Yu. P. Mel'nik, *Sov. Phys. Solid State* 18, 691 (1976).
535. D. A. Gorodetskii, A. M. Kornev and Yu. P. Mel'nik, *Izv. Akad. Nauk SSSR Ser. Fiz.* 28, 1337 (1964).
536. V. B. Voronin and A. G. Naumovets, *Ukr. Fiz. Zhurn.* 13, 1389 (1968).
537. V. B. Voronin, *Soviet Phys. Solid State* 9, 1758 (1968).
538. D. A. Gorodetskii, A. A. Yas'ko, *Sov. Phys. Solid State* 10, 1812 (1969).
539. D. A. Gorodetskii, A. A. Yas'ko and S. A. Shevlyakov, *Izv. Akad. Nauk SSSR, Ser. Fiz.* 35, 436 (1971).
540. V. B. Voronin and A. G. Naumovets, *Izv. Akad. Nauk SSSR Ser. Fiz.* 35, 325 (1971).
541. G. E. Hill, J. Marklund and J. Martinson, *Surface Sci.* 24, 435 (1971).
542. D. Paraschkevov, W. Schlenk, R. P. Bajpai and E. Bauer, Proc. 7th Intern. Vac. Congr. and 3rd Intern. Conf. Solid Surfaces, Vienna 1737 (1977).
543. E. Bauer, H. Poppa, G. Todd and F. Bonczek, *J. Appl. Physics* 45, 5164 (1974).
544. N. J. Taylor, *Surface Sci.* 4, 161 (1966).
545. A. R. Moss and B. H. Blott, *Surface Sci.* 17, 240 (1969).
546. E. Bauer, H. Poppa, G. Todd and P. R. Davis, *J. Appl. Physics* 48, 3773 (1977).
547. J. B. Hudson and C. M. Lo, *Surface Sci.* 36, 141 (1973).
548. P. D. Augustus and J. P. Jones, *Surface Sci.* 64, 713 (1977).
549. R. G. Jones and D. L. Perry, *Surface Sci.* 71, 59 (1978).
550. D. A. Gorodetskii and A. A. Yas'ko, *Sov. Phys. Solid State* 14, 636 (1972).
551. E. Bauer, H. Poppa and G. Todd, *Thin Solid Films* 28, 19 (1975).
552. D. A. Gorodetskii and A. A. Yas'ko, *Sov. Phys. Solid State* 11, 640 (1969).
553. B. J. Hopkins, G. D. Watts, *Surface Sci.* 47, 195 (1975).
554. B. J. Hopkins, G. D. Watts, *Surface Sci.* 45, 77 (1974).
555. D. A. Gorodetskii, A. A. Yas'ko, *Sov. Phys. Solid State* 13, 1085 (1971).
556. P. J. Estrup, J. Anderson and W. E. Danforth, *Surface Sci.* 4, 286 (1966).
557. P. J. Estrup and J. Anderson, *Surface Sci.* 7, 255 (1967).
558. P. J. Estrup and J. Anderson, *Surface Sci.* 8, 101 (1967).
559. J. H. Pollard, *Surface Sci.* 20, 269 (1970).
560. J. Anderson, P. J. Estrup and W. E. Danforth, *Appl. Phys. Lett.* 7, 122 (1965).
561. R. E. Schlier and H. E. Farnsworth, *J. Phys. Chem. Solids* 6, 271 (1958).
562. H. D. Shih, F. Jona, D. W. Jepsen and P. M. Marcus, *Phys. Rev. B* 15, 5550 (1977).
563. H. D. Shih, F. Jona, D. W. Jepsen and P. M. Marcus, *Phys. Rev. B* 15, 5561 (1971).
564. H. D. Shih, F. Jona, D. W. Jepsen and P. M. Marcus, *Comm. on Physics* 1, 25 (1976).
565. D. A. Gorodetskii and A. N. Knysh, *Surface Sci.* 40, 636 (1973).
566. D. A. Gorodetskii and A. N. Knysh, *Surface Sci.* 40, 651 (1973).
567. T. Shigematsu, S. Hine and T. Takada, *J. Crystal Growth* 43, 531 (1978).
568. T. Narusawa, S. Shimizu and S. Komiya, *J. Vac. Sci. Technol.* 16, 366 (1979).
569. R. J. Baird, R. C. Ku and P. Wynblatt, *J. Vac. Sci. Technol.* 16, 435 (1979).
570. P. A. Thiel, J. T. Yates and W. H. Weinberg, *J. Vac. Sci. Technol.* 16, 438 (1979).
571. D. E. Ibbotson, J. C. Taylor and W. H. Weinberg, *J. Vac. Sci. Technol.* 16, 439 (1979).
572. S. P. Weeks and J. E. Rowe, *J. Vac. Sci. Technol.* 16, 470 (1979).
573. C. R. Brundle, E. Silverman and R. J. Madix, *J. Vac. Sci. Technol.* 16, 474 (1979).

574. P. H. Citrin, P. Eisenberger, R. C. Hewitt and H. H. Farrell, *J. Vac. Sci. Technol.* 16, 537 (1979).
575. A. Ignatiev, H. B. Nielsen and D. L. Adams, *J. Vac. Sci. Technol.* 16, 552 (1979).
576. T. N. Taylor, J. W. Rogers and W. P. Ellis, *J. Vac. Sci. Technol.* 16, 581 (1979).
577. T. W. Capehart and T. N. Rhodin, *J. Vac. Sci. Technol.* 16, 594 (1979).
578. L. J. Clarke, *J. Vac. Sci. Technol.* 16, 651 (1979).
579. B. J. Mrstik, S. Y. Tong, M. A. Van Hove, *J. Vac. Sci. Technol.* 16, 1258 (1979).
580. A. T. Hubbard, *J. Vac. Sci. Technol.* 17, 49 (1980).
581. G. B. Fischer, B. A. Sexton and J. L. Gland, *J. Vac. Sci. Technol.* 17, 144 (1980).
582. P. R. Norton, D. K. Creber and J. A. Davies, *J. Vac. Sci. Technol.* 17, 149 (1980).
583. J. J. Zinck and W. H. Weinberg, *J. Vac. Sci. Technol.* 17, 188 (1980).
584. H. L. Davis and D. M. Zehner, *J. Vac. Sci. Technol.* 17, 190 (1980).
585. J. R. Noonan and H. L. Davis, *J. Vac. Sci. Technol.* 17, 194 (1980).
586. J. F. Delord, A. G. Schrott and S. C. Fain, Jr., *J. Vac. Sci. Technol.* 17, 517 (1980).
587. L. E. Firment and G. A. Somorjai, *J. Vac. Sci. Technol.* 17, 574 (1980).
588. W. Mönch and H. Gant, *J. Vac. Sci. Technol.* 17, 1094 (1980).
589. J. Massies, F. Dezaly and N. T. Linh, *J. Vac. Sci. Technol.* 17, 1134 (1980).
590. P. Hollins and T. Pritchard, *Surface Sci.* 99, L389-394 (1980).
591. M. A. Chesters, Ph.D. Thesis, London University (1972).
592. J. Pritchard, *J. Vac. Sci. Technol.* 89, 486 (1979).
593. P. Hollins and J. Pritchard, *Surface Sci.* 89, 486 (1979).
594. L. J. Gerenser and R. C. Baetzold, *Surface Sci.* 99, 259 (1980).
595. R. J. Behm, K. Christmann and G. Ertl, *Surface Sci.* 99, 320 (1980).
596. S. D. Bader, T. W. Orent and L. Richter, *Bull. Am. Phys. Soc.* 24, 468 (1979).
597. S. D. Bader, *Surface Sci.* 99, 392 (1980).
598. P. Feulner, S. Kulkarni, E. Umbach and D. Menzel, *Surface Sci.* 99, 489 (1980).
599. K. J. Rawlings, *Surface Sci.* 99, 507 (1980).
600. B. A. Sexton and G. E. Mitchell, *Surface Sci.* 99, 523 (1980).
601. F. L. Baudais, H. J. Borschke, J. D. Fedyk and M. J. Digna, *Surface Sci.* 100, 210 (1980).
602. G. Guillot, R. Riwan and J. Lecante, *Surface Sci.* 59, 581 (1976).
603. E. J. Ko and R. J. Madix, *100*, L449 (1980).
604. K. J. Rawlings, G. G. Price and B. J. Hopkins, *Surface Sci.* 100, 289 (1980).
605. M. Kitson and R. M. Lambert, *Surface Sci.* 100, 368 (1980).
606. P. Delescluse and A. Masson, *Surface Sci.* 100, 423 (1980).
607. M. Perdureau and J. Oudar, *Surface Sci.* 20, 80 (1970).
608. T. Edmonds, J. J. McCarroll and R. C. Pitkethly, *J. Vac. Sci. Technol.* 8, 68 (1971).
609. P. H. Holloway, and J. B. Hudson, *Surface Sci.* 33, 56 (1972).
610. H. H. Farrell, *Surface Sci.* 100, 613 (1980).
611. C. Oshima, M. Aono, T. Tanaka, S. Kawai, S. Zaima and Y. Shimbata, *Surface Sci.* 102, 312 (1981).
612. L. J. Clarke, *Surface Sci.* 102, 331 (1981).
613. L. J. Clarke, Ph.D. Thesis, Cambridge, U.K. (1978).
614. R. J. Gorte and J. L. Gland, *Surface Sci.* 102, 348 (1981).
615. T. S. Wittrig, D. E. Ibbotson and W. H. Weinberg, *Surface Sci.* 102, 506 (1981).
616. P. Hofmann, K. Horn and A. M. Bradshaw, *Surface Sci.* 105, L260 (1981).
617. G. L. Nyberg and N. V. Richardson, *Surface Sci.* 85, 335 (1979).
618. S. Calisti and J. Suzanne, *Surface Sci.* 105, L255 (1981).
619. S. K. Shi, J. A. Schreifels and J. M. White, *Surface Sci.* 105, 1 (1981).
620. D. Pöso, W. Ranke and K. Jacobi, *Surface Sci.* 105, 77 (1981).
621. D. W. Goodman, and M. Kiskinova, *Surface Sci.* 105, L265 (1981).
622. H. D. Hagstrum and G. E. Becker, *Proc. Roy. Soc. (London)* A331, 395 (1971).
623. G. B. Fisher, *Surface Sci.* 62, 31 (1977).
624. F. Solymosi and J. Kiss, *Surface Sci.* 104, 181 (1981).
625. L. Peralta, Y. Berthier and M. Huber, *Surface Sci.* 104, 435 (1981).
626. J. L. Gland and E. B. Kollin, *Surface Sci.* 104, 478 (1981).
627. G. Rouda and F. Pratesi, *Surface Sci.* 104, 609 (1981).
628. E. Bauer and T. Engel, *Surface Sci.* 71, 695 (1978).
629. S. Calisti and J. Suzanne, *Surface Sci.* 105, L255 (1981).
630. P. Hofmann, K. Horn and A. M. Bradshaw, *Surface Sci.* 105, L260 (1981).

631. S. K. Shi, J. A. Schreifels and J. M. White, *Surface Sci.* 105, 1 (1981).
632. D. Pöss, W. Ranke and K. Jacobi, *Surface Sci.* 105, 77 (1981).
633. H. H. Madden, *Surface Science* 105, 129 (1981).
634. P. Michel and C. Jardin, *Surface Sci.* 36, 478 (1973).
635. G. W. Simmons and D. J. Dwyer, *Surface Sci.* 48, 373 (1975).
636. C. Leygraf and G. Hultquist, *Surface Sci.* 61, 61 (1976).
637. D. W. Goodman and M. Kiskinova, *Surface Sci.* 105, L265 (1981).
638. S. A. Flodström, C. W. B. Martinson, R. Z. Bockrach, S. B. M. Hagström and R. S. Bauer, *Phys. Rev. Lett.* 40, 907 (1978).
639. T. Ichikawa and S. Ino, *Surface Sci.* 105, 395 (1981).
640. D. J. Godfrey and D. P. Woodruff, *Surface Sci.* 105, 438 (1981).
641. D. J. Godfrey and D. P. Woodruff, *Surface Sci.* 105, 459 (1981).
642. T. Takahashi, H. Takiguchi and A. Ebina, *Surface Sci.* 105, 475 (1981).
643. M. K. Debe and D. A. King, *Surface Sci.* 81, 193 (1978).
644. H. M. Kramer and E. Bauer, *Surface Sci.* 107, 1 (1981).
645. T. N. Taylor and P. J. Estrup, *J. Vac. Sci. Technol.* 10, 26 (1973).
646. S. Prigge, H. Roux and E. Bauer, *Surface Sci.* 107, 101 (1981).
647. N. D. Spencer and R. M. Lambert, *Surface Sci.* 107, 237 (1981).
648. T. N. Taylor and W. P. Ellis, *Surface Sci.* 107, 249 (1981).
649. D. L. Adams and H. B. Nielsen, *Surface Sci.* 107, 305 (1981).
650. P. W. Davies and R. M. Lambert, *Surface Sci.* 107, 391 (1981).
651. P. W. Davies and R. M. Lambert, *Surface Sci.* 95, 571 (1980).
652. R. J. Koestner, M. A. Van Hove and G. A. Somorjai, *Surface Sci.* 107, 439 (1981).
653. P. J. Goddard and R. M. Lambert, *Surface Sci.* 107, 519 (1981).
654. M. P. Cox and R. M. Lambert, *Surface Sci.* 107, 547 (1981).
655. H. Namba, J. Dennille and J. M. Gilles, *Surface Sci.* 108, 446 (1981).
656. J. F. Wendelken, *Surface Sci.* 108, 605 (1981).
657. F. Solymosi and J. Kiss, *Surface Sci.* 108, 641 (1981).
658. M. Kitson and K. M. Lambert, *Surface Sci.* 109, 60 (1981).
659. T. Oyama, S. Ohi, A. Kawazu and G. Tominaga, *Surface Sci.* 109, 82 (1981).
660. E. I. Ko and R. J. Madix, *Surface Sci.* 109, 221 (1981).
661. K. J. Rawlings, S. D. Foulis and B. J. Hopkins, *Surface Sci.* 108, 49 (1981).
662. M. Kiskinova and D. W. Goodman, *Surface Sci.* 108, 64 (1981).
663. P. R. Norton, J. A. Davies, D. K. Creber, C. W. Sitter and T. E. Jackman, *Surface Sci.* 108, 205 (1981).
664. R. Ducros, M. Housley, G. Piquard and M. Alnot, *Surface Sci.* 108, 235 (1981).
665. S. B. Lee, M. Weiss and G. Ertl, *Surface Sci.* 108, 357 (1981).
666. F. Solymosi and J. Kiss, *Surface Sci.* 108, 368 (1981).
667. W. S. Yang and F. Jona, *Surface Sci.* 109, L505 (1981).
668. D. Dahlgren and J. C. Hemminger, *Surface Sci.* 109, L513 (1981).
669. P. A. Dowben, M. Grunze and R. G. Jones, *Surface Sci.* 109, L519 (1981).
670. M. Kiskinova and D. W. Goodman, *Surface Sci.* 109, L555 (1981).
671. J. W. A. Sachtler, M. A. Van Hove, J. P. Biberian and G. A. Somorjai, *Surface Sci.* 110, 19 (1981).
672. M. W. Holmes and D. A. King, *Surface Sci.* 110, 120 (1981).
673. M. Kitson and R. M. Lambert, *Surface Sci.* 110, 205 (1981).
674. C. J. Schramm, Jr., M. A. Langell and S. L. Bernasek, *Surface Sci.* 110, 217 (1981).
675. P. W. Davies and R. M. Lambert, *Surface Sci.* 110, 227 (1981).
676. F. P. Netzer and T. E. Madey, *Surface Sci.* 110, 251 (1981).
677. D. E. Ibbotson, T. S. Wittrig and W. H. Weinberg, *Surface Sci.* 110, 294 (1981).
678. D. E. Ibbotson, T. S. Wittrig and W. H. Weinberg, *Surface Sci.* 110, 313 (1981).
679. F. C. Schouten, E. T. Brake, O. L. J. Gijzeman and G. A. Bootsma, *Surface Sci.* 74, 1 (1978).
680. S. J. White, D. P. Woodruff, B. W. Holland and R. S. Zimmer, *Surface Sci.* 74, 34 (1978).
681. A. Steinbrunn, P. Dumas and J. C. Colson, *Surface Sci.* 74, 201 (1978).
682. S. D. Bader, J. M. Blakely, M. B. Brodsky, R. J. Friddle and R. L. Panosh, *Surface Sci.* 74, 405 (1978).
683. J. P. Biberian, *Surface Sci.* 74, 437 (1978).
684. B. Goldstein and D. J. Szostak, *Surface Sci.* 74, 461 (1978).

685. F. P. Netzer and R. A. Wille, *Surface Sci.* 74, 547 (1978).
686. C. A. Papageorgopoulos, *Surface Sci.* 75, 17 (1978).
687. K. Yoshida and G. A. Somorjai, *Surface Sci.* 75, 46 (1978).
688. C. S. Mckee, L. V. Remny and M. W. Roberts, *Surface Sci.* 75, 92 (1978).
689. J. L. Gland and V. L. Korehak, *Surface Sci.* 75, 733 (1978).
690. H. Ibach and S. Lehwald, *Surface Sci.* 76, 1 (1978).
691. H. Conrad, G. Ertl and J. Küppers, *Surface Sci.* 76, 323 (1978).
692. T. E. Madey and J. T. Yates, Jr., *Surface Sci.* 76, 397 (1978).
693. T. E. Felter and P. J. Estrup, *Surface Sci.* 76, 464 (1978).
694. A. J. Van Boommel and J. E. Crombeen, *Surface Sci.* 76, 499 (1978).
695. H. Albers, W. J. J. Van Der Wal, O. L. J. Gijzemann and G. A. Bootsma, *Surface Sci.* 77, 1 (1978).
696. H. Hopster and H. Ibach, *Surface Sci.* 77, 109 (1978).
697. P. Drathen, W. Ranke and K. Jacobi, *Surface Sci.* 77, L162 (1978).
698. K. A. Prior, K. Schwaha and R. M. Lambert, *Surface Sci.* 77, 193 (1978).
699. W. Y. Ching, D. L. Huber, M. G. Lagally and G. C. Wang, *Surface Sci.* 77, 550 (1978).
700. K. J. Rawlings, B. J. Hopkins and S. D. Foulías, *Surface Sci.* 77, 561 (1978).
701. C. M. Chan, S. L. Cunningham, K. L. Luke, W. H. Weinberg and S. P. Withrow, *Surface Sci.* 78, 15 (1978).
702. J. P. Jones and E. W. Roberts, *Surface Sci.* 78, 37 (1978).
703. C. Argile and G. E. Rhead, *Surface Sci.* 78, 115 (1978).
704. C. Argile and G. E. Rhead, *Surface Sci.* 78, 125 (1978).
705. P. J. Goddard and R. M. Lambert, *Surface Sci.* 79, 93 (1979).
706. J. L. Taylor, D. E. Ibbotson and W. H. Weinberg, *Surface Sci.* 79, 349 (1979).
707. M. Alff and W. Moritz, *Surface Sci.* 80, 24 (1979).
708. G. Maire, P. Legare and Lindauer, *Surface Sci.* 80, 238 (1979).
709. C. W. B. Martinson and S. A. Flodström, *Surface Sci.* 80, 306 (1979).
710. J. Massies, P. Elienne, N. T. Linh, *Surface Sci.* 80, 550 (1979).
711. S. A. Lindgren and L. Wallden, *Surface Sci.* 80, 620 (1979).
712. M. K. Debe and D. A. King, *Surface Sci.* 81, 193 (1979).
713. T. Engel, P. Bornemann and E. Bauer, *Surface Sci.* 81, 252 (1979).
714. K. Schwaha, N. D. Spencer and R. M. Lambert, *Surface Sci.* 81, 273 (1979).
715. E. D. Williams, C. M. Chan and W. H. Weinberg, *Surface Sci.* 81, L309 (1979).
716. E. D. Williams and W. H. Weinberg, *Surface Sci.* 82, 93 (1979).
717. K. Oura and T. Hamawa, *Surface Sci.* 82, 202 (1979).
718. J. F. Van Der Veen, R. M. Tromp, R. G. Smeenk and F. W. Saris, *Surface Sci.* 82, 468 (1979).
719. M. G. Cattania, M. Simonetta and M. Tescari, *Surface Sci.* 82, L615 (1979).
720. C. G. Shaw and S. C. Fain, Jr., *Surface Sci.* 83, 1 (1979).
721. M. D. Chim and S. C. Fain, Jr., *Phys. Rev. Lett.* 39, 146 (1977).
722. D. G. Castner and G. A. Somorjai, *Surface Sci.* 83, 60 (1979).
723. R. Pantel, M. Bujor and J. Bardolle, *Surface Sci.* 83, 228 (1979).
724. E. Bertel, K. Schwaha and F. P. Netzer, *Surface Sci.* 83, 439 (1979).
725. H. L. Danis, J. R. Noonan and L. H. Jenkins, *Surface Sci.* 83, 559 (1979).
726. Y. Fujinaga, *Surface Sci.* 84, 1 (1979).
727. P. A. Thiel, E. D. Williams, J. T. Yates, Jr. and W. H. Weiberg, *Surface Sci.* 84, 54 (1979).
728. G. Broden and H. P. Bonzel, *Surface Sci.* 84, 106 (1979).
729. L. K. Verheij, J. A. Van Den Berg and D. G. Armour, *Surface Sci.* 84, 408 (1979).
730. M. G. Barthes and G. E. Rhead, *Surface Sci.* 85, L211 (1979).
731. P. R. Novtom, J. A. Davies, D. P. Jackson and N. Matsunami, *Surface Sci.* 85, 269 (1979).
732. Y. Y. Tu, J. M. Blakely, *Surface Sci.* 85, 276 (1979).
733. G. G. Price, K. J. Rawlings and B. J. Hopkins, *Surface Sci.* 85, 379 (1979).
734. C. Benndorf, K. H. Gressmann, J. Kessler, W. Kirstein and F. Thieme, *Surface Sci.* 85, 389 (1979).
735. D. A. Gorodetsky, Y. P. Melnik, V. K. Sklyar and V. A. Usenko, *Surface Sci.* 85, L503 (1979).
736. A. Kawazu, Y. Saito, N. Ogiwara, T. Otsuki and G. Tominaga, *Surface Sci.* 86, 108 (1979).
737. Y. Fujinaga, *Surface Sci.* 86, 581 (1979).
738. M. Aono, R. Nishitani, C. Oshima, T. Tanaka, E. Bannai and S. Kawai, *Surface Sci.* 86, 631 (1979).
739. F. C. Schouten, O. L. J. Gijzeman and G. A. Bootsma, *Surface Sci.* 87, 1 (1979).
740. S. R. Kelemen and T. E. Fischer, *Surface Sci.* 87, 53 (1979).

741. A. Glachant and U. Bardi, *Surface Sci.* 87, 187 (1979).
742. S. Hengrasmee, P. R. Watson, D. C. Frost and K. A. R. Mitchell, *Surface Sci.* 87, L249 (1979).
743. J. Küppers, F. Nitschke, K. Wandelt and G. Ertl, *Surface Sci.* 87, 295 (1979).
744. A. Kahn, D. Kanani, P. Mark, P. W. Chye, C. Y. Su, I. Lindau and W. E. Spicer, *Surface Sci.* 87, 325 (1979).
745. J. H. Onuferko, D. P. Woodruff and B. W. Holland, *Surface Sci.* 87, 357 (1979).
746. H. Nilhus, *Surface Sci.* 87, 561 (1979).
747. K. Heinz, E. Lang and K. Müller, *Surface Sci.* 87, 595 (1979).
748. E. Bauer and H. Poppa, *Surface Sci.* 88, 31 (1979).
749. M. N. Read and G. J. Russell, *Surface Sci.* 88, 95 (1979).
750. F. H. P. M. Habraken, G. A. Bootsma, P. Hofmann, S. Hachicha and A. M. Bradshaw, *Surface Sci.* 88, 285 (1979).
751. R. G. Jones and D. L. Perry, *Surface Sci.* 88, 331 (1979).
752. P. A. Dowben and R. G. Jones, *Surface Sci.* 88, 348 (1979).
753. R. G. Jones, *Surface Sci.* 88, 367 (1979).
754. W. Moritz and D. Wolf, *Surface Sci.* 88, L29 (1979).
755. M. Prutton, J. A. Walker, M. R. Welton-Cook, R. C. Felton and J. A. Ramsey, *Surface Sci.* 89, 95 (1979).
756. C. W. B. Madinson, S. A. Flodström, J. Rundgren and P. Westrin, *Surface Sci.* 89, 102 (1979).
757. P. A. Dowben and R. G. Jones, *Surface Sci.* 89, 114 (1979).
758. C. Somerton and D. A. King, *Surface Sci.* 89, 391 (1979).
759. M. Grunze, R. K. Driscoll, G. N. Burland, J. C. L. Cornish and J. Pritchard, *Surface Sci.* 89, 381 (1979).
760. S. M. Davis and G. A. Somorjai, *Surface Sci.* 91, 73 (1980).
761. L. J. Clarke, *Surface Sci.* 91, 131 (1980).
762. J. C. Hamilton and J. M. Blakely, *Surface Sci.* 91, 199 (1980).
763. M. Salmeron and G. A. Somorjai, *Surface Sci.* 91, 373 (1980).
764. P. R. Davis, *Surface Sci.* 91, 385 (1980).
765. C. M. Chan, M. A. Van Hove, W. H. Weiberg and E. D. Williams, *Surface Sci.* 91, 440 (1980).
766. G. Hanke, E. Lang, K. Heinz and K. Müller, *Surface Sci.* 91, 551 (1980).
767. G. L. Price and B. G. Baker, *Surface Sci.* 91, 571 (1980).
768. H. I. Lee, G. Praline and J. M. White, *Surface Sci.* 91, 581 (1980).
769. S. Hengrasmee, P. R. Watson, D. C. Frost and K. A. R. Mitchell, *Surface Sci.* 92, 71 (1980).
770. P. Nishitani, S. Kawai, H. Iwasaki, S. Nakamura, M. Aono and T. Tanaka, *Surface Sci.* 92, 191 (1980).
771. D. A. King and G. Thomas, *Surface Sci.* 92, 201 (1980).
772. R. S. Li and L. X. Tu, *Surface Sci.* 92, L71 (1980).
773. O. Oda and G. E. Rhead, *Surface Sci.* 92, 617 (1980).
774. G. A. Garwood, Jr. and A. T. Hubbard, *Surface Sci.* 92, 467 (1980).
775. R. Nishitani, M. Aono, T. Tanaka, C. Oshima, S. Kawai, H. Iwasaki and S. Nakamura, *Surface Sci.* 93, 535 (1980).
776. A. H. Mahan, T. W. Riddle, F. B. Duming and G. K. Walters, *Surface Sci.* 93, 550 (1980).
777. J. Anderson and P. J. Estrup, *J. Chem. Phys.* 46, 563 (1967).
778. C. W. Seabury, T. N. Rhodin, R. J. Purtell and R. P. Merrill, *Surface Sci.* 93, 117 (1980).
779. Y. Sakisaka, M. Miyamura, J. Tamaki, M. Nishijima and M. Onchi, *Surface Sci.* 93, 327 (1980).
780. R. A. Barker, S. Semancik, P. J. Estrup, *Surface Sci.* 94, L162 (1980).
781. F. Bonczek, T. Engel and E. Bauer, *Surface Sci.* 94, 57 (1980).
782. S. Y. Tong, A. Maldonado, C. H. Li, and M. A. Van Hove, *Surface Sci.* 94, 73 (1980).
783. J. Benziger, and R. J. Madix, *Surface Sci.* 94, 119 (1980).
784. M. Textor, I. D. Gay and R. Mason, FRS, *Proc. Roy. Soc. (London)* A356, 37 (1977).
785. W. Erley, *Surface Sci.* 94, 281 (1980).
786. G. Pirug, G. Broden and H. P. Bonzel, *Surface Sci.* 94, 323 (1980).
787. D. T. Ling and W. E. Spicer, *Surface Sci.* 94, 403 (1980).
788. M. E. Bridge and R. M. Lambert, *Surface Sci.* 94, 469 (1980).
789. O. Nishikawa, M. Wada and M. Konishi, *Surface Sci.* 97, 16 (1980).
790. U. Bardi, A. Glachant and M. Bienfait, *Surface Sci.* 97, 137 (1980).
791. R. J. Baird, R. C. Ku and P. Wynblatt, *Surface Sci.* 97, 346 (1980).

792. N. Osakahe, Y. Tamishiro, K. K. Yagi and G. Honjo, *Surface Sci.* 97, 393 (1980).
793. E. Bertel and F. P. Netzer, *Surface Sci.* 97, 409 (1980).
794. R. G. Kirby, C. S. McKee and L. V. Renny, *Surface Sci.* 97, 457 (1980).
795. T. Ichikawa and S. Ino, *Surface Sci.* 97, 489 (1980).
796. F. Bönczek, T. Engel and E. Bauer, *Surface Sci.* 97, 595 (1980).
797. B. E. Hayden, E. Schweizer, R. Kötzt and A. M. Bradshaw, *Surface Sci.* 111, 26 (1981).
798. A. G. Schrott and S. C. Fain, Jr., *Surface Sci.* 111, 39 (1981).
799. K. J. Rawlings, S. D. Foulas and B. J. Hopkins, *Surface Sci.* 111, L690 (1981).
800. T. Sakamoto and H. Kawanami, *Surface Sci.* 111, 177 (1981).
801. W. M. Daniel, Y. Kim, H. C. Peebles and J. M. White, *Surface Sci.* 111, 189 (1981).
802. T. Ichikawa, *Surface Sci.* 111, 227 (1981).
803. B. Z. Olshanetsky and V. I. Mashanov, *Surface Sci.* 111, 414 (1981).
804. B. Z. Olshanetsky, V. I. Mashanov and A. I. Nikiforov, *Surface Sci.* 111, 429 (1981).
805. M. Salmeron, L. Brewer and G. A. Somorjai, *Surface Sci.* 112, 207 (1981).
806. G. A. Garwood, Jr. and A. T. Hubbard, *Surface Sci.* 112, 281 (1981).
807. M. Saitoh, F. Shoji, K. Oura and T. Hanawa, *Surface Sci.* 112, 306 (1981).
808. M. A. Langell and S. L. Bernasek, *J. Vac. Sci. Technol.* 17, 1287 (1980).
809. S. Shimizu and S. Komiya, *J. Vac. Sci. Technol.* 18, 765 (1981).
810. W. Erley, *J. Vac. Sci. Technol.* 18, 472 (1981).
811. T. E. Madey, J. G. Houston, C. W. Seabury and T. N. Rhodin, *J. Vac. Sci. Technol.* 18, 476 (1981).
812. M. A. Passler, T. H. Lin and A. Ignatiev, *J. Vac. Sci. Technol.* 18, 481 (1981).
813. R. J. Baird and W. Eberhardt, *J. Vac. Sci. Technol.* 18, 538 (1981).
814. S. Semancik and P. J. Estrup, *J. Vac. Sci. Technol.* 18, 541 (1981).
815. R. A. Barker and P. J. Estrup, *J. Vac. Sci. Technol.* 18, 546 (1981).
816. G. V. Hansson, R. Z. Bachrach, R. S. Bauer and P. Chiaradia, *J. Vac. Sci. Technol.* 18, 550 (1981).
817. B. W. Walker and P. C. Stair, *J. Vac. Sci. Technol.* 18, 591 (1981).
818. C. W. Seabury, T. N. Rhodin, R. J. Purtell and R. P. Merrill, *J. Vac. Sci. Technol.* 18, 602 (1981).
819. B. W. Lee, R. K. Ni, N. Masud, X. R. Wang, D. C. Wang and M. Rowe, *J. Vac. Sci. Technol.* 19, 294 (1981).
820. B. B. Pate, P. M. Stefan, C. Binns, P. J. Jupiter, M. L. Shek, I. Lindau and W. E. Spicer, *J. Vac. Sci. Technol.* 19, 349 (1981).
821. E. I. Ko and R. J. Madix, *J. Phys. Chem.* 85, 4019 (1981).
822. C. M. Chan and W. H. Weinberg, *J. Chem. Phys.* 71, 3988 (1979).
823. K. Christmann, R. J. Behm, G. Ertl, M. A. Van Hove and W. H. Weinberg, *J. Chem. Phys.* 70, 4168 (1979).
824. L. L. Kesmodel, L. H. Dubois and G. A. Somorjai, *J. Chem. Phys.* 70, 2180 (1979).
825. G. E. Thomas and W. H. Weinberg, *J. Chem. Phys.* 70, 1437 (1979).
826. G. Pirug, H. P. Bonzel, H. Hopster and H. Ibach, *J. Chem. Phys.* 71, 593 (1979).
827. C. M. Chan and W. H. Weinberg, *J. Chem. Phys.* 71, 2788 (1979).
828. Y. Larher and A. Terlain, *J. Chem. Phys.* 72, 1052 (1980).
829. E. D. Williams, P. A. Thiel, W. H. Weinberg and J. T. Yates, Jr., *J. Chem. Phys.* 72, 3496 (1980).
830. D. E. Ibbotson, T. S. Wittrig and W. H. Weinberg, *J. Chem. Phys.* 72, 4885 (1980).
831. L. H. Dubois, D. G. Castner and G. A. Somorjai, *J. Chem. Phys.* 72, 5234 (1980).
832. S. K. Shi and J. M. White, *J. Chem. Phys.* 73, 5889 (1980).
833. F. Nitschke, G. Ertl and J. Küppers, *J. Chem. Phys.* 74, 5911 (1981).
834. R. A. Barker and P. J. Estrup, *J. Chem. Phys.* 74, 1442 (1981).
835. P. A. Thiel, F. M. Hoffmann and W. H. Weinberg, *J. Chem. Phys.* 75, 5556 (1981).
836. S. R. Kelemen and A. Kaldor, *J. Chem. Phys.* 75, 1530 (1981).
837. J. A. Strosio, S. R. Bare and W. Ho, *Surface Sci.* 154, 35 (1985).
838. E. J. Van Loenen, A. E. M. J. Fischer, J. F. van der Veen and F. Legoues, *Surface Sci.* 154, 52 (1985).
839. L. A. DeLouise and N. Winograd, *Surface Sci.* 154, 79 (1985).
840. C. Klauber, M. D. Alvey and J. T. Yates, Jr., *Surface Sci.* 154, 139 (1985).
841. E. Daugy, P. Mathiez, F. Salvan and J. M. Layet, *Surface Sci.* 154, 267 (1985).
842. M. T. Paffett, C. T. Campbell, T. N. Taylor and S. Srinivasan, *Surface Sci.* 154, 284 (1985).
843. F. Zaera and G. A. Somorjai, *Surface Sci.* 154, 303 (1985).
844. I. Chorkendorff, J. Kofoed and J. Onsgaard, *Surface Sci.* 152/153, 749 (1985).

845. G. Strasser, G. Rosina, E. Bertel and F. P. Netzer, *Surface Sci.* 152/153, 765 (1985).
846. B. Poelsema, L. K. Verheij and G. Comsa, *Surface Sci.* 152/153, 851 (1985).
847. Y. Canivez, M. Wautelet, L. D. Laude and R. Andrew, *Surface Sci.* 152/153, 995 (1985).
848. P. Koke, A. Goldmann, W. Mönch, G. Wolfgarten and J. Pollmann, *Surface Sci.* 152/153, 1001 (1985).
849. I. Hernandez-Calderón and H. HLchst, *Surface Sci.* 152/153, 1035 (1985).
850. P. Morgen, W. Wurth and E. Umbach, *Surface Sci.* 152/153, 1086 (1985).
851. C. Pirri, J. C. Peruchetti, G. Gewinner and J. Derrien, *Surface Sci.* 152/153, 1106 (1985).
852. I. Hernandez-Calderon, *Surface Sci.* 152/153, 1130 (1985).
853. B. Cord and R. Courths, *Surface Sci.* 152/153, 1141 (1985).
854. P. C. Pond and D. Cherns, *Surface Sci.* 152/153, 1197 (1985).
855. S. Kennov, S. Ladas and C. Papageorgopoulos, *Surface Sci.* 152/153, 1213 (1985).
856. A. Taleb-Ibrahimi, V. Mercier, C. A. Sébenne, D. Bolmont and P. Chen, *Surface Sci.* 152/153, 1228 (1985).
857. E. Daugy, P. Mathiez, F. Salvan, J. M. Layet and J. Derrien, *Surface Sci.* 152/153, 1239 (1985).
858. J. T. Grant and T. W. Haas, *Surf. Sci.* 19, 347 (1970). (1985).
859. S. M. Francis and N. V. Richardson, *Surface Sci.* 152/153, 63 (1985).
860. J. R. Noonan, H. L. Davis and W. Erley, *Surface Sci.* 152/153, 142 (1985).
861. M. S. Zei, Y. Nakai, D. Weick and G. Lehmpfuhl, *Surface Sci.* 152/153, 254 (1985).
862. C. J. Barnes, M. Lindroos and M. Pessa, *Surface Sci.* 152/153, 260 (1985).
863. H. Asonen, C. J. Barnes, A. Salokatve and M. Pessa, *Surface Sci.* 152/153, 262 (1985).
864. K. Gürtler and K. Jacobi, *Surface Sci.* 152/153, 272 (1985).
865. J. Cousty, R. Riwan and P. Soukiasian, *Surface Sci.* 152/153, 297 (1985).
866. K. Heinz, H. Hertrich, L. Hammar and K. Müller, *Surface Sci.* 152/153, 303 (1985).
867. K. Christmann, F. Chehab, V. Penka and G. Ertl, *Surface Sci.* 152/153, 356 (1985).
868. F. Chehab, W. Krstein and F. Thieme, *Surface Sci.* 152/153, 367 (1985).
869. K. Griffiths, P. R. Norton, J. A. Davies, W. N. Unertl and T. E. Jackman, *Surface Sci.* 152/153, 374 (1985).
870. P. Hofmann and D. Menzel, *Surface Sci.* 152/153, 382 (1985).
871. J. C. Boulliard and M. Sotto, *Surface Sci.* 152/153, 392 (1985).
872. C. Benndorf, G. Klatte and F. Thieme, *Surface Sci.* 152/153, 399 (1985).
873. A. V. Titov and H. Jagodzinski, *Surface Sci.* 152/153, 409 (1985).
874. K. Hayek, H. Glassl, A. Gutmann, H. Leonhard, M. Prutton, S. P. Tear and M. R. Welton-Cook, *Surface Sci.* 152/153, 419 (1985).
875. J. S. Foord and A. E. Reynolds, *Surface Sci.* 152/153, 426 (1985).
876. C. Harendt, J. Goschnick and W. Hirschwald, *Surface Sci.* 152/153, 453 (1985).
877. G. A. Kok, A. Noordermeer and B. F. Nieuwenhuys, *Surface Sci.* 152/153, 505 (1985).
878. K. Bange, T. E. Madey and J. K. Sass, *Surface Sci.* 152/153, 550 (1985).
879. U. Dobler, K. Baberschke, J. Haase and A. Puschmann, *Surface Sci.* 152/153, 569 (1985).
880. T. E. Madey and C. Benndorf, *Surface Sci.* 152/153, 587 (1985).
881. U. Schwalke, H. Niehus and G. Comsa, *Surface Sci.* 152/153, 596 (1985).
882. H. Hiehus and G. Comsa, *Surface Sci.* 151, L171 (1985).
883. W. Altmann, K. Desinger, M. Donath, V. Dose, A. Goldmann and H. Scheidt, *Surface Sci.* 151, L185 (1985).
884. H. You and S. C. Fain, Jr., *Surface Sci.* 151, 361 (1985).
885. G. R. Gruzalski, D. M. Zehner, J. F. Wendelken and R. S. Hathcock, *Surface Sci.* 151, 430 (1985).
886. E. Bechtold and H. Leonhard, *Surface Sci.* 151, 521 (1985).
887. J. B. Benziger and R. E. Preston, *Surface Sci.* 151, 183 (1985).
888. C. Benndorf and B. Krüger, *Surface Sci.* 151, 271 (1985).
889. K. Morishige, C. Mowforth and R. K. Thomas, *Surface Sci.* 151, 289 (1985).
890. S. R. Bare, J. A. Strosio and W. Ho, *Surface Sci.* 150, 399 (1985).
891. K. H. Rieder and W. Stocker, *Surface Sci.* 150, L66 (1985).
892. A. G. Schrott and J. M. Blakely, *Surface Sci.* 150, L77 (1985).
893. T. J. Vink, O. L. J. Gijzeman and J. W. Geus, *Surface Sci.* 150, 14 (1985).
894. R. P. Furstenuau, G. McDougall and M. A. Langell, *Surface Sci.* 150, 55 (1985).
895. H. C. Peebles, D. D. Beck, J. M. White and C. T. Campbell, *Surface Sci.* 150, 120 (1985).
896. L. Smit, T. E. Derry and J. F. van der Veen, *Surface Sci.* 150, 245 (1985).

897. M. A. Passler, B. W. Lee and A. Ignatiev, *Surface Sci.* 150, 263 (1985).
898. C. Zhang, M. A. Van Hove and G. A. Somorjai, *Surface Sci.* 149, 326 (1985).
899. B. E. Hayden, K. Kretzschmar and A. M. Bradshaw, *Surface Sci.* 149, 394 (1985).
900. D. L. Adams, W. T. Moore and K. A. R. Mitchell, *Surface Sci.* 149, 407 (1985).
901. P. M. Stefan, M. L. Shek and W. E. Spicer, *Surface Sci.* 149, 423 (1985).
902. H. Papp, *Surface Sci.* 149, 460 (1985).
903. W. Ranke and D. Schmeisser, *Surface Sci.* 149, 485 (1985).
904. H. Froitzheim, U. Köhler and H. Lammering, *Surface Sci.* 149, 537 (1985).
905. M. L. Shek, *Surface Sci.* 149, L39 (1985).
906. R. G. Egdell, H. Innes and M. D. Hill, *Surface Sci.* 149, 33 (1985).
907. L. H. Dubois and R. G. Nuzzo, *Surface Sci.* 149, 133 (1985).
908. P. A. Maksym, *Surface Sci.* 149, 157 (1985).
909. R. C. Yeates, J. E. Turner, A. J. Gellman and G. A. Somorjai, *Surface Sci.* 149, 175 (1985).
910. J. Rogozik, J. Küppers and V. Dose, *Surface Sci.* 148, L653 (1984).
911. D. E. Fowler and J. M. Blakely, *Surface Sci.* 148, 265 and 283 (1984).
912. T. Engel, K. H. Rieder and I. P. Batra, *Surface Sci.* 148, 321 (1984).
913. E. R. Moog and M. B. Webb, *Surface Sci.* 148, 338 (1984).
914. H. Pfnür and D. Menzel, *Surface Sci.* 148, 411 (1984).
915. J. A. Strosio, S. R. Bare and W. Ho, *Surface Sci.* 148, 499 (1984).
916. E. G. McRae and R. A. Malic, *Surface Sci.* 148, 551 (1984).
917. V. Maurice, L. Peralta, Y. Berthier and J. Oudar, *Surface Sci.* 148, 623 (1984).
918. P. Cantini and E. Cevasco, *Surface Sci.* 148, 37 (1984).
919. K. H. Rieder and W. Stocker, *Surface Sci.* 148, 139 (1984).
920. G. R. Gruzalski, D. M. Zehner and J. F. Wendelken, *Surface Sci.* 147, L623 (1984).
921. E. G. McRae and P. M. Petroff, *Surface Sci.* 147, 385 (1984).
922. L. C. Dufour, O. Bertrand and N. Floquet, *Surface Sci.* 147, 396 (1984).
923. M. Hanbücken, M. Fukamoto and J. A. Venables, *Surface Sci.* 147, 433 (1984).
924. J. P. Ganon and J. Clavilier, *Surface Sci.* 147, 583 (1984).
925. D. Gorse, B. Salanon, F. Fabre, A. Kara, J. Perreau, G. Armand and J. Lapujoulade, *Surface Sci.* 148, 611, (1984).
926. F. Solymosi and L. Bugyi, *Surface Sci.* 147, 685 (1984).
927. G. J. R. Jones, J. H. Onuferko, D. P. Woodruff and B. W. Holland, *Surface Sci.* 147, 1 (1984).
928. R. J. Behm, P. A. Thiel, P. R. Norton and P. E. Bindner, *Surface Sci.* 147, 143 (1984).
929. E. Langenbach, A. Spitzer and H. Lüth, *Surface Sci.* 147, 179 (1984).
930. T. Solomun, A. Wieckowski, S. D. Rosasco and A. T. Hubbard, *Surface Sci.* 147, 241 (1984).
931. L. A. DeLouise, E. J. White and N. Winograd, *Surface Sci.* 147, 252 (1984).
932. R. Riwan, P. Soukiasian, S. Zuber and J. Cousty, *Surface Sci.* 146, 382 (1984).
933. J. Billy and M. Abon, *Surface Sci.* 146, L525 (1984).
934. E. G. McRae, H.-J. Gossmann and L. C. Feldman, *Surface Sci.* 146, L540 (1984).
935. U. Bardi and P. N. Ross, *Surface Sci.* 146, L555 (1984).
936. P. Hren, D. W. Tu and A. Kahn, *Surface Sci.* 146, 69 (1984).
937. A. Wieckowski, B. C. Schardt, S. D. Rosasco, J. L. Stickney and A. T. Hubbard, *Surface Sci.* 146, 115 (1984).
938. M. Surman, F. Solymosi, R. D. Diehl, P. Hofmann and D. A. King, *Surface Sci.* 146, 135 (1984).
939. E. M. Stuve, R. J. Madix and C. R. Brundle, *Surface Sci.* 146, 155 (1984).
940. E. M. Stuve, S. W. Jorgensen and R. J. Madix, *Surface Sci.* 146, 179 (1984).
941. M. Nishijima, M. Jo and M. Onchi, *Surf. Sci.* 151, L179 (1985).
942. K. Edamoto, Y. Kubota, M. Onchi and M. Nishijima, *Surf. Sci.* 146, L533 (1984).
943. A. Puschmann and J. Haase, *Surf. Sci.* 144, 559 (1984).
944. T. E. Jackman, J. A. Davies, P. R. Norton, W. N. Unertl and K. Griffiths, *Surf. Sci.* 141, L313 (1984).
945. J. F. Wendelken and G.-C. Wang, *Surf. Sci.* 140, 425 (1984).
946. U. Schwalke, H. Niehus and G. Comsa, *Surf. Sci.* 137, 23 (1984).
947. V. Y. Aristov, I. E. Batov and V. A. Grazhulis, *Surf. Sci.* 132, 73 (1983).
948. S. Kono, H. Sakurai, K. Higashiyama and T. Sagawa, *Surf. Sci.* 130, L299 (1983).
949. C. B. Duke, S. L. Richardson, A. Paton and A. Kahn, *Surf. Sci.* L135, 127 (1983).
950. K. E. Foley and N. Winograd, *Surf. Sci.* 122, 541 (1982).

951. C. B. Barger, B. H. Nall and A. N. Jette, *Surf. Sci.* 120, L483 (1982).
952. P. R. Norton, J. W. Goodale and D. K. Creber, *Surf. Sci.* 119, 411 (1982).
953. J. Lapujoulade, Y. L. Cruër, M. Lefort, Y. Lejay and E. Maurel, *Surf. Sci.* 118, 103 (1982).
954. R. I. G. Uhrberg, G. V. Hansson, J. M. Nicholls and S. A. Flodström, *Surf. Sci.* 117, 394 (1982).
955. B. E. Koel, B. E. Bent and G. A. Somorjai, *Surface Sci.* 146, 211 (1984).
956. A. Taleb-Ibrahimi, C. A. Sébenne, D. Bolmont and P. Chen, *Surface Sci.* 146, 229 (1984).
957. M. Trenary, K. J. Uram, F. Bozso and J. T. Yates, Jr., *Surface Sci.* 146, 269 (1984).
958. K. A. Thompson and C. S. Fadley, *Surface Sci.* 146, 281 (1984).
959. K. Ueda, K. Kinoshita and M. Mannami, *Surface Sci.* 145, 261 (1984).
960. J. A. Venables, J. L. Seguin, J. Suzanne and M. Bienfait, *Surface Sci.* 145, 345 (1984).
961. H. Ohtani, B. E. Bent, C. M. Mate and G. A. Somorjai, unpublished results.
962. W. R. Lambert, M. J. Cardillo, P. L. Trevor and R. B. Doak, *Surface Sci.* 145, 519 (1984).
963. H. Conrad, R. Scala, W. Stenzel and R. Unwin, *Surface Sci.* 145, 1 (1984).
964. J. G. Clabes, *Surface Sci.* 145, 87 (1984).
965. M. J. Yacamán and P. Schabes-Retchkiman, *Surface Sci.* 144, L439 (1984).
966. S. T. Ceyer, A. J. Melmed, J. J. Carroll and W. R. Graham, *Surface Sci.* 144, L444 (1984).
967. G. K. Binnig, H. Rohrer, C. Gerber and E. Stoll, *Surface Sci.* 144, 321 (1984).
968. J. S. Villarrubia and W. Ho, *Surface Sci.* 144, 370 (1984).
969. J. Kolaczkiwicz and E. Bauer, *Surface Sci.* 144, 477 (1984).
970. J. Kolaczkiwicz and E. Bauer, *Surface Sci.* 144, 495 (1984).
971. N. Kuwata, T. Asai, K. Kimura and M. Mannami, *Surface Sci.* 144, L393 (1984).
972. J. Jupille, J. Fusy and P. Pareja, *Surface Sci.* 144, L433 (1984).
973. Y. C. Lee, M. Abu-Joudeh and P. A. Montano, *Surface Sci.* 144, 469 (1984).
974. C. T. Campbell and M. T. Paffett, *Surface Sci.* 144, 517 (1984).
975. A. Rolland, J. Bernardini and M. G. Barthes-Labrousse, *Surface Sci.* 143, 579 (1984).
976. F. P. Netzer, D. L. Doering and T. E. Madey, *Surface Sci.* 143, L363 (1984).
977. M. Asscher and G. A. Somorjai, *Surface Sci.* 143, L389 (1984).
978. J. Szeftel and S. Lehwald, *Surface Sci.* 143, 11 (1984).
979. J. L. Gland, R. J. Madix, R. W. McCabe and C. DeMaggio, *Surface Sci.* 143, 46 (1984).
980. F. Stucki, J. Anderson, G. J. Lapeyre and H. H. Farrell, *Surface Sci.* 143, 84 (1984).
981. D. Rieger, R. D. Schnell and W. Steinmann, *Surface Sci.* 143, 157 (1984).
982. T. M. Hupkens and J. M. Fluit, *Surface Sci.* 143, 267 (1984).
983. F. Faló, I. Cano and M. Salmerón, *Surface Sci.* 143, 303 (1984).
984. W. F. Egelhoff, *Surface Sci.* 141, L324 (1984).
985. H. Viehhaus and W. Rossow, *Surface Sci.* 141, 341 (1984).
986. B. Egert, H. J. Grabke, Y. Sakisaka and T. N. Rhodin, *Surface Sci.* 141, 397 (1984).
987. M. Grunze, P. A. Dowben and R. G. Jones, *Surface Sci.* 141, 455 (1984).
988. F. Solymosi, A. Berkó and T. I. Tarnóczy, *Surface Sci.* 141, 533 (1984).
989. L. Marchut, T. M. Buck, G. H. Wheatley and C. J. McMahon, Jr., *Surface Sci.* 141, 549 (1984).
990. J. B. Benziger and R. E. Preston, *Surface Sci.* 141, 567 (1984).
991. P. A. Cox, M. D. Hill, F. Peplinskii and R. G. Egdell, *Surface Sci.* 141, 13 (1984).
992. D. A. Andrews and D. P. Woodruff, *Surface Sci.* 141, 31 (1984).
993. R. G. Tobin, S. Chiang, P. A. Thiel and P. L. Richards, *Surface Sci.* 140, 393 (1984).
994. A. G. Fedorus and V. V. Gonchar, *Surface Sci.* 140, 499 (1984).
995. H. Niehus and G. Comsa, *Surface Sci.* 140, 18 (1984).
996. T. Ichikawa, *Surface Sci.* 140, 37 (1984).
997. W. Krakow, *Surface Sci.* 140, 137 (1984).
998. M. H. Farias, A. J. Gellman, G. A. Somorjai, R. R. Chianelli and K. S. Liang, *Surface Sci.* 140, 181 (1984).
999. J. A. Schaefer, F. Stucki, J. A. Anderson, G. J. Lapeyre and W. Göpel, *Surface Sci.* 140, 207 (1984).
1000. E. Tamura and R. Feder, *Surface Sci.* 139, L191 (1984).
1001. C. T. Campbell and M. T. Paffett, *Surface Sci.* 139, 396 (1984).
1002. J. R. Kingsley, D. Dahlgren and J. C. Hemminger, *Surface Sci.* 139, 417 (1984).
1003. J. Jupille, P. Pareja and J. Fusy, *Surface Sci.* 139, 505 (1984).
1004. U. Seip, M.-C. Tsai Christmann, J. Küppers and G. Ertl, *Surface Sci.* 139, 29 (1984).
1005. C. F. McConville, C. Somerton and D. P. Woodruff, *Surface Sci.* 139, 75 (1984).
1006. W. Mokwa, P. Kohl and G. Heiland, *Surface Sci.* 139, 98 (1984).

1007. C. B. Barger, B. H. Nall and A. N. Jette, *Surface Sci.* 139, 219 (1984).
1008. H.-J. Gossmann and W. M. Gibson, *Surface Sci.* 139, 239 (1984).
1009. Y. Kuk, L. C. Feldman and I. K. Robinson, *Surface Sci.* 138, L168 (1984).
1010. H.-J. Gossmann, J. C. Bean, L. C. Feldman and W. M. Gibson, *Surface Sci.* 138, L175 (1984).
1011. C. Benndorf, C. Nöbl and T. E. Madey, *Surface Sci.* 138, 292 (1984).
1012. L. A. DeLouise and N. Winograd, *Surface Sci.* 138, 417 (1984).
1013. J. Segner, C. T. Campbell, G. Doyen and G. Ertl, *Surface Sci.* 138, 505 (1984).
1014. K. Griffiths, T. E. Jackman, J. A. Davies and P. R. Norton, *Surface Sci.* 138, 113 (1984).
1015. J. Kirschner, *Surface Sci.* 138, 191 (1984).
1016. J. S. Foord and R. M. Lambert, *Surface Sci.* 138, 258 (1984).
1017. M. Hanbücken, H. Neddermeyer and J. A. Venables, *Surface Sci.* 137, L92 (1984).
1018. R. Beaume, J. Suzanne, J. P. Coulomb, A. Glachant and G. Bomchil, *Surface Sci.* 137, L117 (1984).
1019. R. A. Metzger and F. G. Allen, *Surface Sci.* 137, 397 (1984).
1020. J. M. McKay and V. E. Henrich, *Surface Sci.* 137, 463 (1984).
1021. M. Nishijima, H. Kobayashi, K. Edamoto and M. Onchi, *Surface Sci.* 137, 473 (1984).
1022. E. J. van Loenen, M. Iwami, R. M. Tromp and J. F. van der Veen, *Surface Sci.* 137, 1 (1984).
1023. K. Bange, D. E. Grider, T. E. Madey and J. K. Sass, *Surface Sci.* 137, 38 (1984).
1024. P. Ho and J. M. White, *Surface Sci.* 137, 103 (1984).
1025. P. Ho and J. M. White, *Surface Sci.* 137, 117 (1984).
1026. A. Gutmann, G. Zwicker, D. Schmeisser and K. Jacobi, *Surface Sci.* 137, 211 (1984).
1027. D. A. Outka and R. J. Madix, *Surface Sci.* 137, 242 (1984).
1028. D. Bolmont, P. Chen, C. A. Sebenne and F. Proix, *Surface Sci.* 137, 280 (1984).
1029. T. Ichikawa and S. Ino, *Surface Sci.* 136, 267 (1984).
1030. M. Kiskinova, G. Pirug and H. P. Bonzel, *Surface Sci.* 136, 285 (1984).
1031. V. Penka, K. Christmann and G. Ertl, *Surface Sci.* 136, 307 (1984).
1032. A. H. Smith, R. A. Barker and P. J. Estrup, *Surface Sci.* 136, 327 (1984).
1033. S. R. Kelemen and C. A. Mims, *Surface Sci.* 136, L35 (1984).
1034. M. Klaua and T. E. Madey, *Surface Sci.* 136, L42 (1984).
1035. J. L. Stickney, S. D. Rosasco, B. C. Schardt, T. Solomon, A. T. Hubbard and B. A. Parkinson, *Surface Sci.* 136, 15 (1984).
1036. C. Somerton, C. F. McConville, D. P. Woodruff and R. G. Jones, *Surface Sci.* 136, 23 (1984).
1037. K. Horioka, H. Iwasaki, S. Maruno, S. T. Li and S. Nakamura, *Surface Sci.* 136, 121 (1984).
1038. G. Bracco, P. Cantini, E. Cavanna, R. Tatarek and A. Glachant, *Surface Sci.* 136, 169 (1984).
1039. A. J. Gellman, M. H. Farias, M. Salmeron and G. A. Somorjai, *Surface Sci.* 136, 217 (1984).
1040. U. Köhler, M. Alavi and H.-W. Wassmuth, *Surface Sci.* 136, 243 (1984).
1041. C. Argile and G. E. Rhead, *Surface Sci.* 135, 18 (1983).
1042. G. A. Kok, A. Noordermeer and B. E. Nieuwenhuys, *Surface Sci.* 135, 65 (1983).
1043. W. T. Tysoe, G. L. Nyberg and R. M. Lambert, *Surface Sci.* 135, 128 (1983).
1044. J. W. M. Frenken, R. G. Smeenk and J. F. van der Veen, *Surface Sci.* 135, 147 (1983).
1045. C. Benndorf and T. E. Madey, *Surface Sci.* 135, 164 (1983).
1046. G. Quentel and R. Kern, *Surface Sci.* 135, 325 (1983).
1047. R. Kötz and B. E. Hayden, *Surface Sci.* 135, 374 (1983).
1048. C. M. A. M. Mesters, G. Wermer, O. L. J. Gijzeman and J. W. Geus, *Surface Sci.* 135, 396 (1983).
1049. H. Sakurai, K. Higashiyama, S. Kono and T. Sagawa, *Surface Sci.* 134, L550 (1983).
1050. M. Bowker and K. C. Waugh, *Surface Sci.* 134, 639 (1983).
1051. A. P. C. Reed, R. M. Lambert and J. S. Foord, *Surface Sci.* 134, 689 (1983).
1052. N. J. Guddé and R. M. Lambert, *Surface Sci.* 134, 703 (1983).
1053. P. S. Uy, J. Bardolle and M. Bujor, *Surface Sci.* 134, 713 (1983).
1054. R. C. Yeates and G. A. Somorjai, *Surface Sci.* 134, 729 (1983).
1055. R. C. Cinti, T. T. A. Nguyen, Y. Capiomont and S. Kennou, *Surface Sci.* 134, 755 (1983).
1056. J. StLör, R. Jaeger, G. Rossi, T. Kendelewicz and I. Lindau, *Surface Sci.* 134, 813 (1983).
1057. D. Dahlgren and J. C. Hemminger, *Surface Sci.* 134, 836 (1983).
1058. J.-M. Baribeau and J.-D. Carette, *Surface Sci.* 134, 886 (1983).
1059. M. P. Cox, G. Ertl, R. Imbihl and J. Rost, *Surface Sci.* 134, L517 (1983).
1060. K. Gürtler and K. Jacobi, *Surface Sci.* 134, 309 (1983).
1061. R. Feidenhans'l, J. E. Sorensen and I. Stensgaard, *Surface Sci.* 134, 329 (1983).
1062. M. L. Shek, P. M. Stefan, I. Lindau and W. E. Spicer, *Surface Sci.* 134, 399 (1983).

1063. M. L. Shek, P. M. Stefan, I. Lindau and W. E. Spicer, *Surface Sci.* 134, 427 (1983).
1064. Y. Larher, *Surface Sci.* 134, 469 (1983).
1065. T. N. Tayler, C. T. Campbell, J. W. Rogers, Jr., W. P. Ellis and J. M. White, *Surface Sci.* 134, 529 (1983).
1066. P. Hollins and J. Pritchard, *Surface Sci.* 134, 91 (1983).
1067. T. Urao, T. Kanaji and M. Kaburagi, *Surface Sci.* 134, 109 (1983).
1068. R. F. Lin, R. J. Koestner, M. A. Van Hove and G. A. Somorjai, *Surface Sci.* 134, 161 (1983).
1069. M. Schuster and C. Varelas, *Surface Sci.* 134, 195 (1983).
1070. A. Bogen and J. Küppers, *Surface Sci.* 134, 223 (1983).
1071. M. Kiskinova, G. Pirug and H. P. Bonzel, *Surface Sci.* 133, 321 (1983).
1072. S. D. Foulis, K. J. Rawlings and B. J. Hopkins, *Surface Sci.* 133, 377 (1983).
1073. Y. Horio and A. Ichimiya, *Surface Sci.* 133, 393 (1983).
1074. K. Jacobi and H. H. Rotermund, *Surface Sci.* 133, 401 (1983).
1075. J. J. Métois and G. L. Lay, *Surface Sci.* 133, 422 (1983).
1076. R. Feidenhans'l and I. Stensgaard, *Surface Sci.* 133, 453 (1983).
1077. N. Masud, R. Baudoin, D. Aberdam and C. Gaubert, *Surface Sci.* 133, 580 (1983).
1078. S. Nakanishi and T. Horiguchi, *Surface Sci.* 133, 605 (1983).
1079. R. J. Madix, M. Thornburg and S.-B. Lee, *Surface Sci.* 133, L477 (1983).
1080. P. Hofmann, S. R. Bare, N. V. Richardson and D. A. King, *Surface Sci.* 133, L459 (1983).
1081. K. K. Kleinherbers and A. Goldmann, *Surface Sci.* 133, 38 (1983).
1082. D. L. Doering, S. Semancik and T. E. Madey, *Surface Sci.* 133, 49 (1983).
1083. S. R. Kelemen and C. A. Mims, *Surface Sci.* 133, 71 (1983).
1084. R. M. Tromp, R. G. Smeenk, F. W. Saris and D. J. Chadi, *Surface Sci.* 133, 137 (1983).
1085. J. H. Neave, P. K. Larsen, J. F. van der Veen, P. J. Dobson and B. A. Joyce, *Surface Sci.* 133, 267 (1983).
1086. G. V. Hansson, R. I. G. Uhrberg and J. M. Nicholls, *Surface Sci.* 132, 31 (1983).
1087. F. Houzay, G. Guichard, R. Pinchaux, G. Jezequel, F. Solal, A. Barsky, P. Steiner and Y. Petroff, *Surface Sci.* 132, 40 (1983).
1088. P. H. Citrin and J. F. Rowe, *Surface Sci.* 132, 205 (1983).
1089. P. Chen, D. Bolmont and C. A. Sebenne, *Surface Sci.* 132, 505 (1983).
1090. J. R. Waldrop, E. A. Kraut, S. P. Kowalczyk and R. W. Grant, *Surface Sci.* 132, 513 (1983).
1091. Y. Yabuuchi, F. Shoji, K. Oura and T. Hanawa, *Surface Sci.* 131, L412 (1983).
1092. K. H. Rieder and H. Wilsch, *Surface Sci.* 131, 245 (1983).
1093. J. Segner, H. Robota, W. Vielhaber, G. Ertl, F. Frenkel, J. Häger, W. Krieger and H. Walther, *Surface Sci.* 131, 273 (1983).
1094. J. G. Nelson, W. J. Gignac, R. S. Williams, S. W. Robey, J. G. Tobin and D. A. Shirley, *Surface Sci.* 131, 290 (1983).
1095. S. M. Thurgate and P. J. Jennings, *Surface Sci.* 131, 309 (1983).
1096. B. E. Hayden, *Surface Sci.* 131, 419 (1983).
1097. I. Stensgaard and R. Feidenhans'l, *Surface Sci.* 131, L373 (1983).
1098. G. Binning, H. Rohrer, C. Gerber and E. Weibel, *Surface Sci.* 131, L379 (1983).
1099. C. Egawa, S. Naito and K. Tamaru, *Surface Sci.* 131, 49 (1983).
1100. R. Miranda, S. Daiser, K. Wandelt and G. Ertl, *Surface Sci.* 131, 61 (1983).
1101. D. Westphal and A. Goldmann, *Surface Sci.* 131, 92 (1983).
1102. D. Westphal and A. Goldmann, *Surface Sci.* 131, 113 (1983).
1103. D. R. Lloyd and F. P. Netzer, *Surface Sci.* 131, 139 (1983).
1104. G. Zwicker and K. Jacobi, *Surface Sci.* 131, 179 (1983).
1105. R. Miranda, D. Chandesris and J. Lecante, *Surface Sci.* 130, 269 (1983).
1106. J. L. Stickney, S. D. Rosasco, D. Song, M. P. Soriaga and A. T. Hubbard, *Surface Sci.* 130, 326 (1983).
1107. M. Hüttinger and J. Küppers, *Surface Sci.* 130, L277 (1983).
1108. S. Kono, H. Sakurai, K. Higashiyama and T. Sagawa, *Surface Sci.* 130, L299 (1983).
1109. W. P. Ellis, K. A. Thompson and N. S. Nogar, *Surface Sci.* 130, L317 (1983).
1110. J. Lee, J. P. Cowin and L. Wharton, *Surface Sci.* 130, 1 (1983).
1111. T. E. Felter, F. N. Hoffmann, P. A. Thiel and W. H. Weinberg, *Surface Sci.* 130, 163 (1983).
1112. F. M. Hoffmann, T. E. Felter, P. A. Thiel and W. H. Weinberg, *Surface Sci.* 130, 173 (1983).
1113. P. A. Montano, P. P. Vaishnav and E. Boling, *Surface Sci.* 130, 191 (1983).

1114. C. M. Pradier, Y. Berthier and J. Oudar, *Surface Sci.* 130, 229 (1983).
1115. M. Yamamoto and D. N. Seidman, *Surface Sci.* 129, 281 (1983).
1116. V. Maurice, J. J. Legendre and M. Huber, *Surface Sci.* 129, 301 (1983).
1117. V. Maurice, J. J. Legendre and M. Huber, *Surface Sci.* 129, 312 (1983).
1118. R. L. Kurtz and V. E. Henrich, *Surface Sci.* 129, 345 (1983).
1119. P. D. Johnson, D. P. Woodruff, H. H. Farrell, N. V. Smith and M. M. Traum, *Surface Sci.* 129, 366 (1983).
1120. M. P. Cox, J. S. Foord, R. M. Lambert and R. H. Prince, *Surface Sci.* 129, 375 (1983).
1121. P. Marcus, A. Teissier and J. Oudar, *Surface Sci.* 129, 432 (1983).
1122. M. A. Van Hove, R. J. Koestner, J. C. Frost and G. A. Somorjai, *Surface Sci.* 129, 482 (1983).
1123. R. Opila and R. Gomer, *Surface Sci.* 129, 563 (1983).
1124. M. Mattern-Klosson, X. M. Ding, H. Lüth and A. Spitzer, *Surface Sci.* 129, 1 (1983).
1125. E. Conrad and M. B. Webb, *Surface Sci.* 129, 37 (1983).
1126. J. S. Foord, A. P. C. Reed and R. M. Lambert, *Surface Sci.* 129, 79 (1983).
1127. G. Michalk, W. Moritz, H. Pfnür and D. Menzel, *Surface Sci.* 129, 92 (1983).
1128. L. E. Firment and A. Ferretti, *Surface Sci.* 129, 155 (1983).
1129. D. L. Doering and S. Semancik, *Surface Sci.* 129, 177 (1983).
1130. H. Papp, *Surface Sci.* 129, 205 (1983).
1131. P. S. Uy, J. Bardolle and M. Bujor, *Surface Sci.* 129, 219 (1983).
1132. R. Ducros, B. Tardy and J. C. Bertolini, *Surface Sci.* 128, L219 (1983).
1133. A. J. Algra, E. P. T. M. Suurmeijer and A. L. Boers, *Surface Sci.* 128, 207 (1983).
1134. R. M. Tromp, E. J. Van Loenen, M. Iwami, R. G. Smeenk, F. W. Saris, F. Nava and G. Ottaviani, *Surface Sci.* 128, 224 (1983).
1135. I. Stensgaard, R. Feidenhans'l and J. E. Sørensen, *Surface Sci.* 128, 281 (1983).
1136. D. L. Adams, H. E. Nielsen and J. N. Andersen, *Surface Sci.* 128, 294 (1983).
1137. M. Grunze, P. A. Dowben and C. R. Brundle, *Surface Sci.* 128, 311 (1983).
1138. K. H. Rieder, *Surface Sci.* 128, 325 (1983).
1139. A. Ichimiya and Y. Takeuchi, *Surface Sci.* 128, 343 (1983).
1140. C. Benndorf, M. Frank and F. Thieme, *Surface Sci.* 128, 417 (1983).
1141. V. Martinez, F. Soria, M. C. Munoz and J. L. Sacedon, *Surface Sci.* 128, 424 (1983).
1142. R. Baudoin, E. Blanc, C. Gaubert, Y. Gauthier and N. Gnuchev, *Surface Sci.* 128, 22 (1983).
1143. C. Backx, C. P. M. de Groot, P. Biloen and W. M. H. Sachtler, *Surface Sci.* 128, 81 (1983).
1144. B. C. De Cooman, V. D. Vankar and R. W. Vook, *Surface Sci.* 128, 128 (1983).
1145. U. Bardi and G. Rovida, *Surface Sci.* 128, 145 (1983).
1146. K. Truszkowska and M. J. Yacaman, *Surface Sci.* 127, L159 (1983).
1147. C.-F. Ai and T. T. Tsong, *Surface Sci.* 127, L165 (1983).
1148. R. G. Jones, C. F. McConville and D. P. Woodruff, *Surface Sci.* 127, 424 (1983).
1149. M. Salmeron, G. A. Somorjai and R. R. Chianelli, *Surface Sci.* 127, 526 (1983).
1150. J. L. Gland, R. W. McCabe and G. E. Mitchell, *Surface Sci.* 127, L123 (1983).
1151. B. T. Jonker, N. C. Bartelt and R. L. Park, *Surface Sci.* 127, 183 (1983).
1152. S. Maroie, P. A. Thiry, R. Caudano and J. J. Verbist, *Surface Sci.* 127, 200 (1983).
1153. K. H. Rieder, T. Engel, R. H. Swendsen and M. Manninen, *Surface Sci.* 127, 223 (1983).
1154. E. Bauer and H. Poppa, *Surface Sci.* 127, 243 (1983).
1155. S. L. Miles, S. L. Bernasek and J. L. Gland, *Surface Sci.* 127, 271 (1983).
1156. E. Lang, K. Müller, K. Heinz, M. A. Van Hove, R. J. Koestner and G. A. Somorjai, *Surface Sci.* 127, 347 (1983).
1157. F. P. Netzer and T. E. Madey, *Surface Sci.* 127, L102 (1983).
1158. T. Yokotsuka, S. Kono, S. Suzuki and T. Sagawa, *Surface Sci.* 127, (1983).
1159. H. Höchst and I. Hernández-Calderón, *Surface Sci.* 126, 25 (1983).
1160. K. C. Prince and A. M. Bradshaw, *Surface Sci.* 126, 49 (1983).
1161. U. O. Karlsson, G. V. Hansson and S. A. Flodström, *Surface Sci.* 126, 58 (1983).
1162. J. Massardier, B. Tardy, M. Abon and J. C. Bertolini, *Surface Sci.* 126, 154 (1983).
1163. C. Nyberg and C. G. Tengstal, *Surface Sci.* 126, 163 (1983).
1164. A. M. Baró and L. Ollé, *Surface Sci.* 126, 170 (1983).
1165. E. F. J. Didham, W. Allison and R. F. Willis, *Surface Sci.* 126, 219 (1983).
1166. D. P. Jackson, T. E. Jackman, J. A. Davies, W. N. Unertl and P. R. Norton, *Surface Sci.* 126, 226 (1983).

1167. C. Binns, C. Norris, G. C. Smith, H. A. Padmore, M. G. Barthès-Labrousse, *Surface Sci.* 126, 258 (1983).
1168. C. Benndorf, C. Nöbl and F. Thieme, *Surface Sci.* 126, 265 (1983).
1169. N. Vennemann, E. W. Schwarz and M. Neumann, *Surface Sci.* 126, 273 (1983).
1170. J. M. Moison and M. Bensoussan, *Surface Sci.* 126, 294 (1983).
1171. G. Lindauer, P. Lègaré and G. Maire, *Surface Sci.* 126, 301 (1983).
1172. M. Surman, S. R. Bare, P. Hofmann and D. A. King, *Surface Sci.* 126, 349 (1983).
1173. M. G. Cattania, V. Penka, R. J. Behm, K. Christmann and G. Ertl, *Surface Sci.* 126, 382 (1983).
1174. M. Salmerón and G. A. Somorjai, *Surface Sci.* 126, 410 (1983).
1175. K. Khonde, J. Darville and J. M. Gilles, *Surface Sci.* 126, 414 (1983).
1176. S. Tatarenko, R. Ducros and M. Alnot, *Surface Sci.* 126, 422 (1983).
1177. F. Labohm, C. W. R. Engelen, O. L. J. Gijzeman, J. W. Geus and G.A. Bootsma, *Surface Sci.* 126, 429 (1983).
1178. K. Bange, D. Grider and J. K. Sass, *Surface Sci.* 126, 437 (1983).
1179. U. Köhler and H.-W. Wassmuth, *Surface Sci.* 126, 448 (1983).
1180. Z. T. Stott and H. P. Hughes, *Surface Sci.* 126, 455 (1983).
1181. M. Mattern and H. Lüth, *Surface Sci.* 126, 502 (1983).
1182. D. Bolmont, V. Mercier, P. Chen, H. Lhth and C. A. Sebenne, *Surface Sci.* 126, 509 (1983).
1183. E. De Frésart, J. Darville and J. M. Gilles, *Surface Sci.* 126, 518 (1983).
1184. H. Tochihara, *Surface Sci.* 126, 523 (1983).
1185. N. Floquet and L.-C. Dufour, *Surface Sci.* 126, 543 (1983).
1186. J. P. Landuyt, L. Vandenbroucke, R. D. Gryse and J. Vennik, *Surface Sci.* 126, 598 (1983).
1187. A. M. Lahee, W. Allison, R. F. Willis and K. H. Rieder, *Surface Sci.* 126, 654 (1983).
1188. M. Shiojiri, N. Nakamura, C. Kaito and T. Miyano, *Surface Sci.* 126, 719 (1983).
1189. M. Domke, B. Kyvelos and G. Kaindl, *Surface Sci.* 126, 727 (1983).
1190. R. D. Diehl and S. C. Fain, Jr., *Surface Sci.* 125, 116 (1983).
1191. J. Suzanne, J. L. Seguin, H. Taub and J. P. Biberian, *Surface Sci.* 125, 153 (1983).
1192. K. Kjaer, M. Nielsen, J. Bohr, H. J. Lauter and J. P. McTague, *Surface Sci.* 125, 171 (1983).
1193. J. Bohr, M. Nielsen, J. Als-Nielsen, K. Kjaer and J. P. McTague, *Surface Sci.* 125, 181 (1983).
1194. P. Bak and T. Bohr, *Surface Sci.* 125, 279 (1983).
1195. D. E. Taylor and R. L. Park, *Surface Sci.* 125, L73 (1983).
1196. N. Freyer, G. Pirug and H. P. Bonzel, *Surface Sci.* 125, 327 (1983).
1197. M. Welz, W. Moritz and D. Wolf, *Surface Sci.* 125, 473 (1983).
1198. R. J. Madix, J. L. Gland, G. E. Mitchell and B. A. Sexton, *Surface Sci.* 125, 481 (1983).
1199. K. Heinz and G. Besold, *Surface Sci.* 125, 515 (1983).
1200. P. A. Heiney, P. W. Stephens, S. G. J. Mochrie, J. Akimitsu, R. J. Birgeneau and P. M. Horn, *Surface Sci.* 125, 539 (1983).
1201. G. Bracco, P. Cantini, A. Glachant and R. Tatarek, *Surface Sci.* 125, L81 (1983).
1202. H. C. Peebles, D. E. Peebles and J. M. White, *Surface Sci.* 125, L87 (1983).
1203. C. Egawa, S. Naito and K. Tamaru, *Surface Sci.* 125, 605 (1983).
1204. S. Nakanishi and T. Horiguchi, *Surface Sci.* 125, 635 (1983).
1205. B. E. Hayden and A. M. Bradshaw, *Surface Sci.* 125, 787 (1983).
1206. F. Houzay, G. M. Guichar, A. Cros, F. Salvan, P. Pinchaux and J. Derrien, *Surface Sci.* 124, L1 (1983).
1207. R. M. Tromp, E. J. van Loenen, M. Iwami, R. G. Smeenk, F. W. Saris, F. Nava and G. Ottaviani, *Surface Sci.* 124, 1 (1983).
1208. F. P. Netzer and M. M. El Gomati, *Surface Sci.* 124, 26 (1983).
1209. J. A. Gates and L. L. Kesmodel, *Surface Sci.* 124, 68 (1983).
1210. E. G. McRae, *Surface Sci.* 124, 106 (1983).
1211. D. T. Ling, J. N. Miller, D. L. Weissman, P. Pianetta, P. M. Stefan, I. Lindau and W. E. Spicer, *Surface Sci.* 124, 175 (1983).
1212. M. R. McClellan, F. R. McFeely and J. L. Gland, *Surface Sci.* 124, 188 (1983).
1213. B. J. Mrstik, *Surface Sci.* 124, 253 (1983).
1214. S. P. Svensson, J. Kanski, T. G. Andersson and P. O. Nilsson, *Surface Sci.* 124, L31 (1983).
1215. J. Derrien and F. Ringeisen, *Surface Sci.* 124, L35 (1983).
1216. G. Schulze and M. Henzler, *Surface Sci.* 124, 336 (1983).
1217. N. J. Gudde and R. M. Lambert, *Surface Sci.* 124, 372 (1983).

1218. D. Prigge, W. Schlenk and E. Bauer, *Surface Sci.* 123, L698 (1982).
1219. A. Titov and W. Moritz, *Surface Sci.* 123, L709 (1982).
1220. H. Scheidt, M. Glöbl and V. Dose, *Surface Sci.* 123, L728 (1982).
1221. H. Steininger, S. Lehwald and H. Ibach, *Surface Sci.* 123, 1 (1982).
1222. S. Maruno, H. Iwasaki, K. Horioka, S.-T. Li and S. Nakamura, *Surface Sci.* 123, 18 (1982).
1223. G. Le Lay, M. Manneville and J. J. Métois, *Surface Sci.* 123, 117 (1982).
1224. R. Imbihl, R. J. Behm, G. Ertl and W. Moritz, *Surface Sci.* 123, 129 (1982).
1225. M. Maglietta, E. Zanazzi, U. Bardi, D. Sondericker, F. Jona and P. M. Marcus, *Surface Sci.* 123, 141 (1982).
1226. B. Poelsema, R. L. Palmer and G. Comsa, *Surface Sci.* 123, 152 (1982).
1227. D. Dahlgren and J. C. Hemminger, *Surface Sci.* 123, L739 (1982).
1228. G. Popov and E. Bauer, *Surface Sci.* 123, 165 (1982).
1229. A. G. Schrott and S. C. Fain, Jr., *Surface Sci.* 123, 204 (1982).
1230. A. G. Schrott, Q. X. Su and S. C. Fain, Jr., *Surface Sci.* 123, 223 (1982).
1231. J. K. Lang, K. D. Jamison, F. B. Dunning, G. K. Walters, M. A. Passler, A. Ignatiev, E. Tamura and R. Feder, *Surface Sci.* 123, 247 (1982).
1232. H. Steininger, S. Lehwald and H. Ibach, *Surface Sci.* 123, 264 (1982).
1233. D. L. Doering and T. E. Madey, *Surface Sci.* 123, 305 (1982).
1234. D. P. Woodruff, B. E. Hayden, K. Prince and A. M. Bradshaw, *Surface Sci.* 123, 397 (1982).
1235. G. R. Castro and J. Küppers, *Surface Sci.* 123, 456 (1982).
1236. H.-D. Schmick and H.-W. Wassmuth, *Surface Sci.* 123, 471 (1982).
1237. P. R. Norton, J. A. Davies and T. E. Jackmon, *Surface Sci.* 122, L593 (1982).
1238. G. Pirug, H. P. Bonzel and G. Brodén, *Surface Sci.* 122, 1 (1982).
1239. W. H. Cheng and H. H. Kung, *Surface Sci.* 122, 21 (1982).
1240. G. Landgren, S. P. Svensson and T. G. Andersson, *Surface Sci.* 122, 55 (1982).
1241. T. E. Felter, S. A. Steward and F. S. Uribe, *Surface Sci.* 122, 69 (1982).
1242. C. T. Campbell and T. N. Taylor, *Surface Sci.* 122, 119 (1982).
1243. G.-C. Wang and T.-M. Lu, *Surface Sci.* 122, L635 (1982).
1244. F. Solymosi and A. Berko, *Surface Sci.* 122, 275 (1982).
1245. G. Gewinner, J. C. Peruchetti and A. Jaéglé, *Surface Sci.* 122, 383 (1982).
1246. G. Popov and E. Bauer, *Surface Sci.* 122, 433 (1982).
1247. W. T. Moore, S. J. White, D. C. Frost, and K. A. R. Mitchell, *Surf. Sci.* 116, 261 (1982).
1248. S. Astegger and E. Bechtold, *Surface Sci.* 122, 491 (1982).
1249. G. A. Garwood Jr., A. T. Hubbard and J. B. Lumsden, *Surface Sci.* 121, L524 (1982).
1250. L. J. Clarke and L. Morales de la Garza, *Surface Sci.* 121, 32 (1982).
1251. H. Conrad, G. Ertl, J. Küppers, W. Sesselmann and H. Haberland, *Surface Sci.* 121, 161 (1982).
1252. P. A. Thiel, R. J. Behm, P. R. Norton and G. Ertl, *Surface Sci.* 121, L553 (1982).
1253. A. Fujimori, F. Minami and N. Tsuda, *Surface Sci.* 121, 199 (1982).
1254. P. W. Davies, M. A. Quinlan and G. A. Somorjai, *Surface Sci.* 121, 290 (1982).
1255. J. E. Crowell, E. L. Garfunkel and G. A. Somorjai, *Surface Sci.* 121, 303 (1982).
1256. R. J. Koestner, M. A. Van Hove and G. A. Somorjai, *Surface Sci.* 121, 321 (1982).
1257. R. H. Milne, *Surface Sci.* 121, 347 (1982).
1258. J. Y. Katekaru, G. A. Garwood, Jr., J. F. Hershberger and A. T. Hubbard, *Surface Sci.* 121, 396 (1982).
1259. S. B. DiCenzo, G. K. Wertheim and D. N. E. Buchanan, *Surface Sci.* 121, 411 (1982).
1260. J. P. Jones, *Surface Sci.* 121, 487 (1982).
1261. Y. Sakisaka, H. Kato and M. Onchi, *Surface Sci.* 120, 150 (1982).
1262. G. Casalone, M. G. Cattania, F. Merati and M. Simonetta, *Surface Sci.* 120, 171 (1982).
1263. S. E. Greco, J. P. Roux and J. M. Blakely, *Surface Sci.* 120, 203 (1982).
1264. T. W. Capehart, C. W. Seabury, G. W. Graham and T. N. Rhodin, *Surface Sci.* 120, L441 (1982).
1265. K. Heinz, E. Lang, K. Strauss and K. Müller, *Surface Sci.* 120, L401 (1982).
1266. J. A. Gates and L. L. Kesmodel, *Surface Sci.* 120, L461 (1982).
1267. A. Fasana and L. Braicovich, *Surface Sci.* 120, 239 (1982).
1268. K. Christmann and J. E. Demuth, *Surface Sci.* 120, 291 (1982).
1269. A. G. Naumovets and A. G. Fedorus, *Zh. Eksperim. Teor. Fiz.* 68, 1183 (1975) [*Soviet Phys.-JETP* 41, 587 (1976)].
1270. A. Spitzer and H. Lüth, *Surface Sci.* 120, 376 (1982).

1271. T. E. Jackman, J. A. Davies, D. P. Jackson, W. N. Unertl and P. R. Norton, *Surface Sci.* 120, 389 (1982).
1272. G. C. Smith, H. A. Padmore and C. Norris, *Surface Sci.* 119, L287 (1982).
1273. C. B. Barger and B. H. Nall, *Surface Sci.* 119, L319 (1982).
1274. P. J. Dobson, J. H. Neave and B. A. Joyce, *Surface Sci.* 119, L339 (1982).
1275. T. N. Gardiner and E. Bauer, *Surface Sci.* 119, L353 (1982).
1276. A. Ortega, F. M. Hoffman and A. M. Bradshaw, *Surface Sci.* 119, 79 (1982).
1277. M. Grunze, C. R. Brundle, and D. Tomanek, *Surface Sci.* 119, 133 (1982).
1278. G. Comsa, G. Mechttersheimer and B. Poelsema, *Surface Sci.* 119, 159 (1982).
1279. S. Ferrer and H. R. Bonzel, *Surface Sci.* 119, 234 (1982).
1280. C. Park, E. Bauer and H. M. Kramer, *Surface Sci.* 119, 251 (1982).
1281. P. J. Orders, S. Kono, C. S. Fadley, R. Trehan and J. T. Lloyd, *Surface Sci.* 119, 371 (1982).
1282. F. P. Netzer and T. E. Madey, *Surface Sci.* 119, 422 (1982).
1283. J. L. Seguin and J. Suzanne, *Surface Sci.* 118, L241 (1982).
1284. K. H. Rieder, *Surface Sci.* 118, 57 (1982).
1285. A. Spitzer and H. Lüth, *Surface Sci.* 118, 121 (1982).
1286. A. Spitzer and H. Lth, *Surface Sci.* 118, 136 (1982).
1287. G. A. Garwood, Jr. and A. T. Hubbard, *Surface Sci.* 118, 223 (1982).
1288. C. T. Campbell and T. N. Taylor, *Surface Sci.* 118, 401 (1982).
1289. S. A. Flodström and C. W. B. Martinsson, *Surface Sci.* 118, 513 (1982).
1290. E. Roman and R. Riwan, *Surface Sci.* 118, 682 (1982).
1291. J. Ibañez, N. Garcia, J. M. Rojo and N. Cabrera, *Surface Sci.* 117, 23 (1982).
1292. W. Englert, E. Taglauer and W. Heiland, *Surface Sci.* 117, 124 (1982).
1293. E. Lang, W. Grimm and K. Heinz, *Surface Sci.* 117, 169 (1982).
1294. W. Berndt, R. Hora and M. Scheffler, *Surface Sci.* 117, 188 (1982).
1295. W. Hoesler and W. Moritz, *Surface Sci.* 117, 196 (1982).
1296. Y. Y. Aristov, N. I. Golovko, V. A. Grazhulis, Y. A. Ossipyan and V. I. Talyanskii, *Surface Sci.* 117, 204 (1982).
1297. P. Hofmann, S. R. Bare and D. A. King, *Surface Sci.* 117, 245 (1982).
1298. R. Imbihl, R. J. Behm, K. Christmann, G. Ertl and T. Matsushima, *Surface Sci.* 117, 257 (1982).
1299. R. Miranda, F. Yndurain, D. Chandesris, J. Lecante and Y. Petroff, *Surface Sci.* 117, 319 (1982).
1300. R. Kötz, B. E. Hayden, E. Schweizer and A. M. Bradshaw, *Surface Sci.* 117, 331 (1982).
1301. S. Lehwald, H. Ibach and H. Steininger, *Surface Sci.* 117, 342 (1982).
1302. R. Matz and H. Lüth, *Surface Sci.* 117, 362 (1982).
1303. M. Pessa, H. Asonen, R. S. Rao, R. Prasad and A. Bansil, *Surface Sci.* 117, 371 (1982).
1304. K. Horn, C. Mariani and L. Cramer, *Surface Sci.* 117, 376 (1982).
1305. D. Bolmont, P. Chen and C. A. Sébenne, *Surface Sci.* 117, 417 (1982).
1306. S. A. Lindgren, J. Paul and L. Walldén, *Surface Sci.* 117, 426 (1982).
1307. R. Brooks, N. V. Richardson and D. A. King, *Surface Sci.* 117, 434 (1982).
1308. T. E. Madey and F. P. Netzer, *Surface Sci.* 117, 549 (1982).
1309. Ya-Po Hsu, K. Jacobi and H. H. Rotermund, *Surface Sci.* 117, 581 (1982).
1310. J. M. Heras, H. Papp and W. Spiess, *Surface Sci.* 117, 590 (1982).
1311. C. M. A. M. Mesters, A. F. H. Wielers, O. L. J. Gijzeman, G. A. Bootsma and J. W. Geus, *Surface Sci.* 117, 605 (1982).
1312. G. Castro, J. E. Hulse, J. Küppers and A. Rodriguez Gonzalez-Elipse, *Surface Sci.* 117, 621 (1982).
1313. H. Steininger, H. Ibach and S. Lehwald, *Surface Sci.* 117, 685 (1982).
1314. K. E. Foley and N. Winograd, *Surface Sci.* 116, 1 (1982).
1315. V. Jensen, J. N. Andersen, H. B. Nielsen and D. L. Adams, *Surface Sci.* 116, 66 (1982).
1316. R. J. Koestner, J. C. Frost, P. C. Stair, M. A. Van Hove and G. A. Somorjai, *Surface Sci.* 116, 85 (1982).
1317. P. Kaplan, *Surface Sci.* 116, 104 (1982).
1318. L. E. Firment, *Surface Sci.* 116, 205 (1982).
1319. C. Binns and C. Norris, *Surface Sci.* 116, 338 (1982).
1320. J. Carelli and A. Kahn, *Surface Sci.* 116, 380 (1982).
1321. T. S. Wittrig, P. D. Szuromi and W. H. Weinberg, *Surface Sci.* 116, 414 (1982).
1322. A. Cros, F. Houzay, G. M. Guichard and R. Pinchaux, *Surface Sci.* 116, L232 (1982).
1323. C. Park, H. M. Kramer and E. Bauer, *Surface Sci.* 116, 456 (1982).

1324. C. Park, H. M. Kramer and E. Bauer, *Surface Sci.* 116, 467 (1982).
1325. U. Gradmann and G. Waller, *Surface Sci.* 116, 539 (1982).
1326. C. Park, H. M. Kramer and E. Bauer, *Surface Sci.* 115, 1 (1982).
1327. W. T. Tysoe and P. M. Lambert, *Surface Sci.* 115, 37 (1982).
1328. R. Nishitani, C. Oshima, M. Aono, T. Tanaka, S. Kawai, H. Iwasaki and S. Nakamura, *Surface Sci.* 115, 48 (1982).
1329. S. W. Johnson and R. J. Madix, *Surface Sci.* 115, 61 (1982).
1330. J. S. Foord and R. M. Lambert, *Surface Sci.* 115, 141 (1982).
1331. A. Glachant, M. Jaubert, M. Bienfait and G. Boato, *Surface Sci.* 115, 219 (1982).
1332. H. Poppa and F. Soria, *Surface Sci.* 115, L105 (1982).
1333. S. Tougaard and A. Ignatiev, *Surface Sci.* 115, 270 (1982).
1334. T. W. Orent and S. D. Bader, *Surface Sci.* 115, 323 (1982).
1335. M. A. Barteau and R. J. Madix, *Surface Sci.* 115, 355 (1982).
1336. C. Binns and C. Norris, *Surface Sci.* 115, 395 (1982).
1337. E. L. Garfunkel and G. A. Somorjai, *Surface Sci.* 115, 441 (1982).
1338. S. Calisti, J. Suzanne and J. A. Venables, *Surface Sci.* 115, 455 (1982).
1339. G. E. Gdowski and R. J. Madix, *Surface Sci.* 115, 524 (1982).
1340. R. T. Tung, W. R. Graham and A. J. Melmed, *Surface Sci.* 115, 576 (1982).
1341. W. Erley, *Surface Sci.* 114, 47 (1982).
1342. Y. Terada, T. Yoshizuka, K. Oura and T. Hanawa, *Surface Sci.* 114, 65 (1982).
1343. H. Kato, Y. Sakisaka, T. Miyano, K. Kamei, M. Nishijima and M. Onchi, *Surface Sci.* 114, 96 (1982).
1344. J. Massies and N. T. Linh, *Surface Sci.* 114, 147 (1982).
1345. A. Fäldt, *Surface Sci.* 114, 311 (1982).
1346. T. Narusawa, W. M. Gibson and E. Törnqvist, *Surface Sci.* 114, 331 (1982).
1347. G.-C. Wang, J. Unguris, D. T. Pierce and R. J. Celotta, *Surface Sci.* 114, L35 (1982).
1348. Y. Kim, H. C. Peebles and J. M. White, *Surface Sci.* 114, 363 (1982).
1349. D. Dahlgren and J. C. Hemminger, *Surface Sci.* 114, 459 (1982).
1350. G. Ertl, S. B. Lee and M. Weiss, *Surface Sci.* 114, 527 (1982).
1351. D. F. Mitchell and M. J. Graham, *Surface Sci.* 114, 546 (1982).
1352. M. Hanbücken and H. Neddermeyer, *Surface Sci.* 114, 563 (1982).
1353. R. Ryberg, *Surface Sci.* 114, 627 (1982).
1354. P. E. Viljoen, B. J. Wessels, G. L. P. Berning and J. P. Roux, *J. Vac. Sci. Technol.* 20, 204 (1982).
1355. L. C. Feldman, R. J. Culbertson and P. J. Silverman, *J. Vac. Sci. Technol.* 20, 368 (1982).
1356. M. Oku and C. R. Brundle, *J. Vac. Sci. Technol.* 20, 532 (1982).
1357. E. D. Williams and W. H. Weinberg, *J. Vac. Sci. Technol.* 20, 534 (1982).
1358. J. E. Black, T. S. Rahman and D. L. Mills, *J. Vac. Sci. Technol.* 20, 567 (1982).
1359. S.-W. Wang, *J. Vac. Sci. Technol.* 20, 600 (1982).
1360. W. N. Unertl, T. E. Jackman, P. R. Norton, D. P. Jackson and J. A. Davies, *J. Vac. Sci. Technol.* 20, 607 (1982).
1361. D. E. Eastman, F. J. Himpsel and J. F. van der Veen, *J. Vac. Sci. Technol.* 20, 609 (1982).
1363. D. Heskett, F. Greuter, H.-J. Freund and E. W. Plummer, *J. Vac. Sci. Technol.* 20, 623 (1982).
1363. W. F. Egelhoff, Jr., *J. Vac. Sci. Technol.* 20, 668 (1982).
1364. P. H. Holloway and R. A. Outlaw, *J. Vac. Sci. Technol.* 20, 671 (1982).
1365. J. M. Van Hove and P. I. Cohen, *J. Vac. Sci. Technol.* 20, 726 (1982).
1366. Y. J. Chabal, J. E. Rowe and S. B. Christman, *J. Vac. Sci. Technol.* 20, 763 (1982).
1367. A. Kahn, J. Carelli, C. B. Duke, A. Paton and W. K. Ford, *J. Vac. Sci. Technol.* 20, 775 (1982).
1368. K. Khonde, J. Darville and J. M. Gilles, *J. Vac. Sci. Technol.* 20, 834 (1982).
1369. R. J. Culbertson, L. C. Feldman, P. J. Silverman and R. Haight, *J. Vac. Sci. Technol.* 20, 868 (1982).
1370. K. Jacobi, G. W. Graham and T. N. Rhodin, *J. Vac. Sci. Technol.* 20, 878 (1982).
1371. D. A. Outka and R. J. Madix, *J. Vac. Sci. Technol.* 20, 882 (1982).
1372. M. A. Van Hove, R. J. Koestner and G. A. Somorjai, *J. Vac. Sci. Technol.* 20, 886 (1982).
1373. N. J. Wu and A. Ignatiev, *J. Vac. Sci. Technol.* 20, 896 (1982).
1374. D. Haneman and R. Z. Bachrach, *J. Vac. Sci. Technol.* 21, 337 (1982).
1375. A. Kahn, J. Carelli, D. L. Miller and S. P. Kowalczyk, *J. Vac. Sci. Technol.* 21, 380 (1982).
1376. E. Zanazzi, M. Maglietta, U. Bardi, F. Jona and P. M. Marcus, *J. Vac. Sci. Technol. A* 1, 7 (1983).
1377. R. Kaplan, *J. Vac. Sci. Technol. A* 1, 551 (1983).

1378. C. B. Duke, A. Paton and A. Kahn, *J. Vac. Sci. Technol. A* 1, 672 (1983).
1379. S. H. Overbury and P. C. Stair, *J. Vac. Sci. Technol. A* 1, 1055 (1982).
1380. E. D. Williams and D. L. Doering, *J. Vac. Sci. Technol. A* 1, 1188 (1983).
1381. G. Besold, K. Heinz, E. Lang and K. Müller, *J. Vac. Sci. Technol. A* 1, 1473 (1983).
1382. C. B. Duke, A. Paton, W. K. Ford, A. Kahn and G. Scott, *J. Vac. Sci. Technol.* 20, 778 (1982).
1383. P. Skeath, C. Y. Su, I. Lindau and W. E. Spicer, *J. Vac. Sci. Technol.* 20, 779 (1982).
1384. J. M. Moison and M. Bensoussan, *J. Vac. Sci. Technol.* 21, 315 (1982).
1385. J. E. Rowe and P. H. Citrin, *J. Vac. Sci. Technol.* 21, 338 (1982).
1386. B. J. Wacławski, D. T. Pierce, N. Swanson and R. J. Celotta, *J. Vac. Sci. Technol.* 21, 368 (1982).
1387. J. F. van der Veen, L. Smit, P. K. Larsen, J. H. Neave and B. A. Joyce, *J. Vac. Sci. Technol.* 21, 375 (1982).
1388. J. F. Wendelken and G.-C. Wang, *J. Vac. Sci. Technol. A* 2, 888 (1984).
1389. G.-C. Wang and T.-M. Lu, *J. Vac. Sci. Technol. A* 2, 1048 (1984).
1390. J. L. Stickney, S. D. Rosasco, B. C. Schardt and A. T. Hubbard, *J. Phys. Chem.* 88, 251 (1984).
1391. A. T. Hubbard, J. L. Stickney, S. D. Rosasco, M. P. Soriaga and D. Song, *J. Electroanal. Chem. Interfac. Electrochem.* 150, 165 (1983).
1392. T. De Jong, L. Smit, V. V. Korablev, R. M. Tromp and F. W. Saris, *Appl. Surf. Sci.* 10, 10 (1982).
1393. T. Takahashi and A. Ebina, *Appl. Surf. Sci.* 11/12, 268 (1982).
1394. K. Heinz, E. Lang, K. Strauss and K. Müller, *Appl. Surf. Sci.* 11/12, 611 (1982).
1395. K. Müller, E. Lang, H. Endriss and K. Heinz, *Appl. Surf. Sci.* 11/12, 625 (1982).
1396. M. A. Stevens-Kalceff and C. J. Russel, *Appl. Surf. Sci.* 13, 94 (1982).
1397. J. A. Ramsey, *Appl. Surf. Sci.* 13, 159 (1982).
1398. R. Madix, *Appl. Surf. Sci.* 14, 41 (1982).
1399. A. Shih, G. A. Haas and C. R. K. Marrian, *Appl. Surf. Sci.* 16, 93 (1982).
1400. G. Le Lay and J. J. Metois, *Appl. Surf. Sci.* 17, 131 (1982).
1401. W. Wen-Hao and J. Verhoeven, *Appl. Surf. Sci.* 17, 331 (1982).
1402. F. P. Netzer and T. E. Madey, *J. Chem. Phys.* 76, 710 (1982).
1403. L. H. Dubois, *J. Chem. Phys.* 77, 5228 (1982).
1404. J. Suzanne, J. L. Seguin, M. Biefait and E. Lerner, *Phys. Rev. Lett.* 52, 632 (1984).
1405. T. Aruga, H. Tochihara and Y. Murata, *Phys. Rev. Lett.* 52, 1794 (1984).
1406. D. L. Doering and S. Semancik, *Phys. Rev. Lett.* 53, 66 (1984).
1407. R. Ryberg, *Phys. Rev. Lett.* 53, 945 (1984).
1408. S. A. Lindgren, L. Walldén, J. Rundgren and P. Westrin, *Phys. Rev. B* 29, 576 (1984).
1409. J. R. Noonan and H. L. Davis, *Phys. Rev. B* 29, 4349 (1984).
1410. J. Sokolov, F. Jona and P. M. Marcus, *Phys. Rev. B* 29, 5402 (1984).
1411. M. F. Toney and S. C. Fain, Jr., *Phys. Rev. B* 30, 1115 (1984).
1412. F. J. Himpsel, P. M. Marcus, R. Tromp, I. P. Batra, M. R. Cook, F. Jona and H. Liu, *Phys. Rev. B* 30, 2257 (1984).
1413. Z. P. Hu and A. Ignatiev, *Phys. Rev. B* 30, 4856 (1984).
1414. C. Pirri, J. C. Peruchetti, G. Gewinner and J. Derrien, *Phys. Rev. B* 30, 6227 (1984).
1415. G.-C. Wang and T.-M. Lu, *Phys. Rev. Lett.* 50, 2014 (1983).
1416. M. A. Van Hove, R. Lin and G. A. Somorjai, *Phys. Rev. Lett.* 51, 778 (1983).
1417. H. Richter and U. Gerhardt, *Phys. Rev. Lett.* 51, 1570 (1983).
1418. P. K. Wu, J. H. Perepezko, J. T. McKinney and M. G. Lagally, *Phys. Rev. Lett.* 51, 1577 (1983).
1419. A. H. Weiss, I. J. Rosenberg, K. F. Canter, C. B. Duke and A. Paton, *Phys. Rev. B* 27, 867 (1983).
1420. C. B. Duke, A. Paton and A. Kahn, *Phys. Rev. B* 27, 3436 (1983).
1421. I. Hernández-Calderón and H. Höchst, *Phys. Rev. B* 27, 4961 (1983).
1422. P. K. Larsen, J. H. Neave, J. F. van der Veen, P. J. Dobson and B. A. Joyce, *Phys. Rev. B* 27, 4966 (1983).
1423. C. B. Duke, A. Paton, A. Kahn and C. R. Bonapace, *Phys. Rev. B* 27, 6189 (1983).
1424. P. Skeath, C. Y. Su, W. A. Harrison, I. Lindau and W. E. Spicer, *Phys. Rev. B* 27, 6246 (1983).
1425. M. F. Toney, R. D. Diehl and S. C. Fain, Jr., *Phys. Rev. B* 27, 6413 (1983).
1426. C. B. Duke, A. Paton, A. Kahn and C. R. Bonapace, *Phys. Rev. B* 28, 852 (1983).
1427. W. S. Yang and F. Jona, *Phys. Rev. B* 28, 1178 (1983).
1428. W. S. Yang, F. Jona and P. M. Marcus, *Phys. Rev. B* 28, 2049 (1983).
1429. H. Liu, M. R. Cook, F. Jona and P. M. Marcus, *Phys. Rev. B* 28, 6137 (1983).
1430. S. A. Lindgren, L. Walldén, J. Rundgren, P. Westrin and J. Neve, *Phys. Rev. B* 28, 6707 (1983).

1431. G.-C. Wang and T.-M. Lu, *Phys. Rev. B* 28, 6795 (1983).
1432. P. Skeath, I. Lindau, C. Y. Su and W. E. Spicer, *Phys. Rev. B* 28, 7051 (1983).
1433. N. J. Wu and A. Ignatiev, *Phys. Rev. B* 28, 7288 (1983).
1434. W. S. Yang, F. Jona and P. M. Marcus, *Phys. Rev. B* 28, 7377 (1983).
1435. R. D. Diehl, M. F. Toney and S. C. Fain, Jr., *Phys. Rev. Lett.* 48, 177 (1982).
1436. D. L. Adams, H. B. Nielsen, J. N. Andersen, I. Stensgaard, R. Feidenhans'l and J. E. Sorensen, *Phys. Rev. Lett.* 49, 669 (1982).
1437. S. Masuda, M. Nishijima, Y. Sakisaka and M. Onchi, *Phys. Rev. B* 25, 863 (1982).
1438. J. M. Baribeau and J. D. Carette, *Phys. Rev. B* 25, 2962 (1982).
1439. N. J. Wu and A. Ignatiev, *Phys. Rev. B* 25, 2983 (1982).
1440. G. K. Wertheim, S. B. DiCenzo and D. N. E. Buchanan, *Phys. Rev. B* 25, 3020 (1982).
1441. S. Y. Tong and K. H. Lau, *Phys. Rev. B* 25, 7382 (1982).
1442. C. B. Duke, A. Paton, W. K. Ford, A. Kahn and J. Carelli, *Phys. Rev. B* 26, 803 (1982).
1443. R. D. Diehl and S. C. Fain, Jr., *Phys. Rev. B* 26, 4785 (1982).
1444. D.-W. Tu and A. Kahn, *J. Vac. Sci. Technol. A* 2, 511 (1984).
1445. C. B. Duke, A. Paton, and A. Kahn, *J. Vac. Sci. Technol. A* 2, 515 (1984).
1446. J. M. Moison and M. Bensoussan, *Appl. Surf. Sci.* 20, 84 (1984).
1447. Y. B. Lozovyi, V. K. Medvedev, T. P. Smereka, B. M. Palyukh and G. V. Babkin, *Fiz. Tverdogo Tela* 24, 2130 (1982).
1448. L. G. Salmon and T. N. Rhodin, Tenth International Symposium on Gallium Arsenide and Related Compounds, 561 (1983).
1449. V. F. Dvoryankin, A. A. Komarov, V. V. Panteleev, *Izv. Akad. Nauk SSSR Neorg. Mater.* 19, 186 (1983).
1450. R. Kaplan, *J. Appl. Phys.* 56, 1636 (1984).
1451. B. S. Meyerson and M. L. Yu, *J. Electrochem. Soc.* 131, 2366 (1984).
1452. B. E. Hayden and A. M. Bradshaw, *J. Electron Spectrosc. and Relat. Phenom.* 30, 51 (1983).
1453. B. E. Koel and G. A. Somorjai, *J. Electron Spectrosc. and Relat. Phenom.* 29, 287 (1983).
1454. C. Nyberg and C. G. Tengstål, *J. Electron Spectrosc. and Relat. Phenom.* 29, 191 (1983).
1455. A. B. Anton, N. R. Avery, B. H. Toby and W. H. Weinberg, *J. Electron Spectrosc. and Relat. Phenom.* 29, 181 (1983).
1456. A. Oustry, J. Bert, M. Caumont, and M. J. David, *J. Microsc. and Spectrosc. Electron.* 9, 49 (1984).
1457. N. P. Lieske, *J. Phys. and Chem. Solids* 45, 821 (1984).
1458. M. Abu-Joudeh, P. P. Vaishnava, and P. A. Montano, *J. Phys. C* 17, 6899 (1984).
1459. Y. Gauthier, R. Baudoin, Y. Joly, C. Gaubert, and J. Rundgren, *J. Phys. C* 17, 4547 (1984).
1460. J. Sokolov, H. D. Shih, U. Bardi, F. Jona, and P.M. Marcus, *J. Phys. C* 17, 371 (1984).
1461. F. Jona, D. Westphal, A. Goldmann and P.M. Marcus, *J. Phys. C* 16, 3001 (1983).
1462. J. Neve, P. Westrin, J. Rundgren, *J. Phys. C* 16, 1291 (1983).
1463. G. C. Smith, C. Nooris, C. Binns, and H. A. Padmore, *J. Phys. C* 15, 6481 (1982).
1464. H. B. Nielsen, J. N. Andersen, L. Petersen, and D. L. Adams, *J. Phys. C* 15, L1113 (1982).
1465. K. Griffiths, D. A. King, G. C. Aers and J. B. Pendry, *J. Phys. C* 15, 4921 (1982).
1466. S. P. Tear and K. Roll, *J. Phys. C* 15, 5521 (1982).
1467. J. Neve, J. Rundgren and P. Westrin, *J. Phys. C* 15, 4391 (1982).
1468. L. J. Clarke, R. Baudoin and Y. Gauthier, *J. Phys. C* 15, 3249 (1982).
1469. Y. Gauthier, R. Baudoin and L. Clarke, *J. Phys. C* 15, 3231 (1982).
1470. Y. Gauthier, R. Baudoin, C. Gaubert and L. Clarke, *J. Phys. C* 15, 3223 (1982).
1471. M. K. Debe and D. A. King, *J. Phys. C* 15, 2257 (1982).
1472. H. B. Nielsen and D. L. Adams, *J. Phys. C* 15, 615 (1982).
1473. W. T. Moore, D. C. Frost and K. A. R. Mitchell, *J. Phys. C* 15, L5 (1982).
1474. G. Le Lay and J. J. Metois, *J. Phys. Colloq.* 45, No. C5, C5-427-33 (1984).
1475. K. Shoji, H. Ueba, and C. Tatsuyama, *J. Vac. Soc. Jpn.* 26, 778 (1983).
1476. H. -J. Gossmann, L. C. Feldman and W. M. Gibson, *J. Vac. Sci. and Technol. B* 2, 407 (1984).
1477. J. A. Schaefer, F. Stucki, D. J. Frankel, W. Gopel and G. J. Lapeyre, *J. Vac. Sci. and Technol. B* 2, 359 (1984).
1478. C. B. Duke, A. Paton, A. Kahn and D. W. Tu, *J. Vac. Sci. and Technol. B* 2, 366 (1984).
1479. C. Maillot, H. Roulet and G. Dufour, *J. Vac. Sci. and Technol. B* 2, 316 (1984).
1480. C. B. Duke and A. Paton, *J. Vac. Sci. and Technol. B* 2, 327 (1984).
1481. Y. Fujinaga, *J. Vac. Soc. Jpn.* 25, 468 (1982).

1482. J. Tang, *J. Zhejiang Univ.* 18 81 (1984).
1483. K. Shoji, M. Hyodo, H. Ueba and C. Tatsuyama, *Jpn. J. Appl. Phys. Part 1*, 22, 1482 (1983).
1484. Y. Yabuuchi, F. Shoji, K. Oura, T. Hanawa, Y. Kishikawa and S. Okada, *Jpn. J. Appl. Phys. Part 1*, 21, L752 (1982).
1485. H. Nakamatsu, Y. Yamamoto, S. Kawai, K. Oura and T. Hanawa, *Jpn. J. Appl. Phys. Part 2*, 22, L461 (1983).
1486. K. Shoji, M. Hyodo, H. Ueba and C. Tatsuyama, *Jpn. J. Appl. Phys. Part 2*, 22, L200 (1983).
1487. Y. Yabuuchi, F. Shoji, K. Oura, T. Hanawa, Y. Kishikawa and S. Okada, *Jpn. J. Appl. Phys. Part 2*, 21, L752 (1982).
1488. S. Maruno, H. Iwasaki, K. Horioka, Sung-te Li, S. Nakamura, *Jpn. J. Appl. Phys. Part 2*, 21, L263 (1982).
1489. K. Horioka, H. Iwasaki, A. Ichimiya, S. Maruno, S. Te Li and S. Nakamura, *Jpn. J. Appl. Phys. Part 2*, 21, L189 (1982).
1490. Y. Y. Tomashpol'skii, E. N. Lubnin, M. A. Sevost'yanov and V. I. Kukuev, *Kristallografiya* 27, 1152 (1982).
1491. V. F. Dvoryankin, A. Y. Mityagin and V. V. Panteleev, *Kristallografiya* 27, 349 (1982).
1492. D. M. Zehner and C. W. White, *Laser Annealing of Semiconductors*, 281 (1982).
1493. R. Ramanathan and J. M. Blakeley, *Mater. Lett.* 2, 12 (1983).
1494. H. Iwasaki, S. Maruno, K. Horioka, S. -T. Li and S. Nakamura, *Molecular Beam Epitaxy and Clean Surface Techniques. Collected Papers of 2nd International Symposium*, 305 (1982).
1495. H. Sato, A. Ebina and T. Takahashi, *Molecular Beam Epitaxy and Clean Surface Techniques. Collected Papers of 2nd International Symposium*, 309 (1982).
1496. K. Oura, Y. Yabuuchi, F. Shoji, T. Hanawa and S. Okada, *Proceedings of the 6th International Conference on Ion Beam Analysis* 23 (1983).
1497. D. P. Woodruff and K. Horn, *Philos. Mag. A* 47, L5 (1983).
1498. D. L. Adams, H. B. Nielsen and J. N. Andersen, *Phys. Scr. T4*, 22 (1983).
1499. F. Houzay, G. M. Guichard, A. Cros, F. Salvan, R. Pinchaux and J. Derrien, *Physica B and C* 117, 840 (1983).
1500. V. G. Lifshits, V. G. Zavodinskii and N. I. Plyusnin, *Phys. Chem. and Mech. Surf.* 2, 784 (1984).
1501. P. P. Lutsishin and T. N. Nakhodkin, *Phys. Chem. and Mech. Surf.* 1, 3596 (1984).
1502. V. A. Grazhulis, A. M. Ionov, V. F. Kuleshov, *Phys. Chem. and Mech. Surf.* 2, 540 (1984).
1503. T. Matsubara, *Prog. Theor. Phys.* 71, 399 (1984).
1504. H. Sato, A. Ebina and T. Takahashi, *Rec. Electr. and Commun. Eng., Conversazione Tohoku Univ.* 51, 9 (1982).
1505. J. C. Dupuy, B. Vilotitch and A. Sibai, *Rev. Phys. Appl.* 19, 965 (1984).
1506. G. L. P. Berning and W. J. Coleman, *S. Afr. J. Phys.* 7 (1984).
1507. P. Chen, D. Bolmont and C. A. Sebenne, *Thin Solid Films* 111, 367 (1984).
1508. P. Godowski and S. Mroz, *Thin Solid Films* 111, 129 (1984).
1509. V. D. Vankar, R. W. Vook and B. C. De Cooman, *Thin Solid Films* 102, 313 (1983).
1510. V. E. de Carvalho, M. W. Cook, P. G. Cowell, O. S. Heavens, M. Prutton and S. P. Tear, *Vacuum* 34, 893 (1984).
1511. B. J. Hinch, M. S. Foster, G. Jennings and R. F. Willis, *Vacuum* 33, 864 (1983).
1512. R. D. Diehl, S. C. Fain, Jr., J. Talbot, D. J. Tildesley and W. A. Steele, *Vacuum* 33, 857 (1983).
1513. D. P. Woodruff and K. Horn, *Vacuum* 33, 633 (1983).
1514. G. J. R. Jones and B. W. Holland, *Vacuum* 33, 627 (1983).
1515. S. Tatarenko and R. Ducros, *Vide Les Couches Minces* 38, 121 (1983).
1516. V. V. Gonchar, Y. M. Kagan, O. V. Kanash, A. G. Naumovets and A. G. Fedorus, *Zh. Eksp. and Teor. Fiz.* 84, 249 (1983).
1517. T. De Yong, W. A. S. Douma, L. Smit, V. V. Korablev and F. W. Saris, *J. Vac. Sci. and Technol. B* 1, 888 (1983).
1518. J. M. Woodall, P. Oelhafen, T. N. Jackson, J. L. Freeouf and G. D. Pettit, *J. Vac. Sci. and Technol. B* 1, 795 (1983).
1519. P. Oelhafen, J. L. Freeouf, G. D. Pettit and J. M. Woodall, *J. Vac. Sci. and Technol. B* 1, 787 (1983).
1520. P. Zurcher, J. Anderson, D. Frankel and G. J. Lapeyre, *J. Vac. Sci. and Technol. B* 1, 682 (1983).
1521. A. Kahn, C. R. Bonapace, C. B. Duke and A. Paton, *J. Vac. Sci. and Technol. B* 1, 613 (1983).
1522. J. R. Lince, J. G. Nelson and R. S. Williams, *J. Vac. Sci. and Technol. B* 1, 553 (1983).
1523. W. S. Yang, F. Jona and P. M. Marcus, *J. Vac. Sci. and Technol. B* 1, 718 (1983).

1524. R. S. Bauer, *J. Vac. Sci. and Technol. B* 1, 314 (1983).
1525. J. Kofoed, I. Chorkendorff and J. Onsgaard, *Solid State Commun.* 52, 283 (1984).
1526. B. T. Jonker and R. L. Park, *Solid State Commun.* 51, 871 (1984).
1527. K. Christemann, V. Penka, R. J. Behm, F. Chehab and G. Ertl, *Solid State Commun.* 51, 487 (1984).
1528. R. Feder and W. Monch, *Solid State Commun.* 50, 311 (1984).
1529. J. Derrien and F. Ringeisen, *Solid State Commun.* 50, 627 (1984).
1530. J. Sokolov, F. Jona and P. M. Marcus, *Solid State Commun.* 49, 307 (1984).
1531. J. Sokolov, H. D. Shih, U. Bardi, F. Jona and P. M. Marcus, *Solid State Commun.* 48, 739 (1983).
1532. A. Faldt and H. P. Myers, *Solid State Commun.* 48, 253 (1983).
1533. W. S. Yang and F. Jona, *Solid State Commun.* 48, 377 (1983).
1534. B. E. Hayden, K. C. Prince, P. J. Davie, G. Paolucci and A. M. Bradshaw, *Solid State Commun.* 48, 325 (1983).
1535. F. Stucki, J. A. Schaefer, J. R. Anderson, G. J. Lapeyre and W. Gopel, *Solid State Commun.* 47, 795 (1983).
1536. K. Horioka, H. Iwasaki, S. Maruno, S. Te Li and S. Nakamura, *Solid State Commun.* 47, 55 (1983).
1537. P. Chen, D. Bolmont and C. A. Sebenne, *Solid State Commun.* 46, 689 (1983).
1538. M. Pessa and O. Jylha, *Solid State Commun.* 46, 419 (1983).
1539. M. Maglietta, A. Fallavollita and G. Rovida, *Solid State Commun.* 46, 273 (1983).
1540. N. J. Wu and A. Ignatiev, *Solid State Commun.* 46, 59 (1983).
1541. R. D. Bringans and B. Z. Bachrach, *Solid State Commun.* 45, 83 (1983).
1542. R. Feder, *Solid State Commun.* 45, 51 (1983).
1543. H. Kobayashi, K. Edamoto, M. Onchi and M. Nishijima, *Solid State Commun.* 44, 1449 (1982).
1544. P. Chen, D. Bolmont and C. Sebenne, *Solid State Commun.* 44, 1191 (1982).
1545. D. Westphal, A. Goldmann, F. Jona and P. M. Marcus, *Solid State Commun.* 44, 685 (1982).
1546. C. Binns, C. Norris, I. Lindau, M. L. Shek, B. Pate, P. M. Stefan and W. E. Spicer, *Solid State Commun.* 43, 853 (1982).
1547. W. S. Yang, F. Jona and P. M. Marcus, *Solid State Commun.* 43, 847 (1982).
1548. M. Maglietta, *Solid State Commun.* 43, 395 (1982).
1549. S. J. White, D. C. Frost, K. A. R. Mitchell, *Solid State Commun.* 42, 763 (1982).
1550. W. S. Yang and F. Jona, *Solid State Commun.* 42, 49 (1982).
1551. W. S. Yang, J. Sokolov, F. Jona and P. M. Marcus, *Solid State Commun.* 41, 191 (1982).
1552. T. Weir and G. W. Simmons, *AIP Conf. Proc. No. 84*, 113 (1982).
1553. M. Maglietta, *Appl. Phys. A* 31, 165 (1983).
1554. T. D. Jong, W. A. S. Douma, J. F. Van der Veen, F. W. Saris and J. Haisma, *Appl. Phys. Lett.* 42, 1037 (1983).
1555. K. Oura, S. Okada, Y. Kishikawa and T. Hanawa, *Appl. Phys. Lett.* 40, 138 (1982).
1556. J. L. Stickney, S. D. Rosasco and A. T. Hubbard, *J. Electrochem. Soc.* 131, 260 (1984).
1557. J. K. Sass, K. Bange, R. Dohl, E. Piltz, and R. Unwin, *Ber. Bunsenges, Phys. Chem.* 88, 354 (1984).
1558. Y. Nakai, M. S. Zei, D. M. Kolb and G. Lehmppfuhl, *Ber. Bunsenges, Phys. Chem.* 88, 340 (1984).
1559. M. Ohno, Y. Nakanishi and G. Shimaoka, *Bull. Res. Inst. Electron Shizuoka Univ.* 19, 19 (1984).
1560. C. Klauber, M. D. Alvey and J. T. Yates, *Chem. Phys. Lett.* 106, 477 (1984).
1561. R. Ramanathan, M. Quinlan and H. Wise, *Chem. Phys. Lett.* 106, 87 (1984).
1562. G. C. Smith, C. Norris and C. Binns, *J. Phys. C* 17, 4389 (1984).
1563. C. Ping, D. Bolmont and C. A. Sebenne, *J. Phys. C* 17, 4897 (1984).
1564. C. Binns, M. G. Barthes-Labrousse and C. Norris, *J. Phys. C* 17, 1465 (1984).
1565. M. Maglietta, *J. Phys. C* 17, 363 (1984).
1566. J. N. Andersen, H. B. Nielsen, L. Petersen and D. L. Adams, *J. Phys. C* 17, 173 (1984).
1567. F. Proix, A. Akremi and Z. T. Zhong, *J. Phys. C* 16, 5449 (1983).
1568. G. J. Hughes, A. Mckinley and R. H. Williams, *J. Phys. C* 16, 2391 (1983).
1569. T. C. Gainey and B. J. Hopkins, *J. Phys. C* 16, 975 (1983).
1570. A. Mckinley, G. J. Hughes and R. H. Williams, *J. Phys. C* 15, 7049 (1982).
1571. S. A. Lindgren, J. Paul, L. Wallden and P. Westrin, *J. Phys. C* 15, 6285 (1982).
1572. P. Chen, D. Bolmont and C. A. Sebenne, *J. Phys. C* 15, 6101 (1982).
1573. V. Montgomery, R. H. Williams, *J. Phys. C* 15, 5887 (1982).
1574. M. R. Welton-Cook and W. Berndt, *J. Phys. C* 15, 5691 (1982).
1575. D. Bolmont, P. Chen, F. Proix and C. A. Sebenne, *J. Phys. C* 15, 3639 (1982).
1576. N. Masud, *J. Phys. C* 15, 3209 (1982).

1577. F. Storbeck, *Acta Phys. Acad. Sci. Hung* 49, 75 (1980).
1578. L. R. Sheng, L.-X. Tu, *Acta Phys. Sin. (China)* 29, 524 (1980).
1579. D. J. Chadi, *Appl. Opt.* 19, 3971 (1980).
1580. M. Maglietta, E. Zanazzi, F. Jona, D. W. Jepsen, P. M. Marcus, *Appl. Phys.* 15, 409 (1978).
1581. M. Maglietta, *Appl. Phys. A31*, 165 (1983).
1582. Y. Nakai, M. S. Zei, D. M. Kolb, G. Lehmpfuhl, *Ber. Bunsenges, Phys. Chem.* 88, 340 (1984).
1583. A. Steinbrum, P. Dumas, J. C. Colson, C. R. Hebd, *Seances. Acad. Sci. Ser. C* 290, 329 (1980).
1584. K. A. Prior, K. Schwaha, M. E. Bridge, R. M. Lambert, *Chem. Phys. Lett.* 65, 472 (1979).
1585. G. Casalone, M. G. Cattania, M. Simonetta and M. Tescari, *Chem. Phys. Lett.* 61, 36 (1979).
1586. I. L. Kesmodel, L. H. Dubois, G. A. Somorjai, *Chem. Phys. Lett.* 56, 267 (1978).
1587. M. G. Lagally, Wang Gwo-Ching and Lu Toh-Ming, *CRC Crit. Rev. Solid State and Mater. Sci.* 7, 233 (1978).
1588. H. J. Mussig and W. Arabczyk, *Cryst. Res. and Technol.* 16, 827 (1981).
1589. M. Klaua, K. Meinel, O. P. Pchelyakov, V. A. Ivanchenko and S. I. Stenin, *Sov. Phys. Solid State* 23, 1501 (1981).
1590. M. S. Gupalo, V. K. Medvedev, B. M. Palyukh and T. P. Smereka, *Sov. Phys. Solid State* 23, 1211 (1981).
1591. V. K. Medvedev and I. N. Yakovkin, *Sov. Phys. Solid State* 23, 379 (1981).
1592. S. A. Knyazev and G. K. Zyryanov, *Sov. Phys. Solid State*, 22, 1554 (1980).
1593. M. S. Gupalo, V. K. Medvedev, B. M. Palyukh and T. P. Smereka, *Sov. Phys. Solid State* 21, 568 (1979).
1594. V. K. Medvedev and I. N. Yakovkin, *Sov. Phys. Solid State*, 21, 187 (1979).
1595. H. F. Winters, *IBM, J. Res. and Dev.* 22, 260 (1978).
1596. C. R. Brundle, *IBM, J. Res. and Dev.*, 22, 235 (1978).
1597. A. Ignatiev, *IEEE Trans. Nucl. Sci. NS-26*, 1824 (1979).
1598. S. A. Isa, *Iraqi J. Sci.* 20, 225 (1979).
1599. N. Stoner, M. A. Van Hove, S. Y. Tong, and M.B. Webb, *Phys. Rev. Lett.*, 40, 243 (1978).
1600. Mark J. Cardillo and G. E. Becker, *Phys. Rev. Lett.*, 40, 1148 (1978).
1601. F. Jona, K. O. Legg, H. D. Shih D. W. Jepsen, and P. M. Marcus, *Phys. Rev. Lett.* 40, 1466 (1978).
1602. J. Suzanne, J. P. Coulomb, M. Bienfait, M. Matecki, A. Thomy, B. Croset and C. Marti, *Phys. Rev. Lett.* 41, 760 (1978).
1603. R. A. Barker and P. J. Estrup, *Phys. Rev. Lett.*, 41, 1307 (1978).
1604. M. Passler, A. Ignatiev, F. Jona, D. W. Jepsen and P. M. Marcus, *Phys. Rev. Lett.* 43, 360 (1979).
1605. S. Andersson and J. B. Pendry, *Phys. Rev. Lett.*, 43, 363 (1979).
1606. G. Gewinner, J. C. Peruchetti, A. Jaegle and R. Riedinger, *Phys. Rev. Lett.* 43, 935 (1979).
1607. R. J. Meyer, L. J. Brillson, A. Kahn, D. Kanani, J. Carelli, J. L. Yeh, G. Margaritondo and A. D. Katnani, *Phys. Rev. Lett.* 46, 440 (1979).
1608. H. D. Shih, F. Jona, D. W. Jepsen and P. M. Marcus, *Phys. Rev. Lett.* 46, 731 (1979).
1609. K. Griffiths, C. Kendon, D. A. King and J. B. Pendry, *Phys. Rev. Lett.* 46, 1584 (1981).
1610. E. G. McRae and C. W. Caldwell, *Phys. Rev. Lett.* 46, 1632 (1981).
1611. M. Jaubert, A. Glachant, M. Bienfait and G. Boato, *Phys. Rev. Lett.* 46, 1679 (1981).
1612. C. B. Duke, R. J. Meyer, A. Paton and P. Marck, *Phys. Rev. B* 18, 4225 (1978).
1613. B. W. Lee, R. Alsenz, A. Ignatiev and M. A. Van Hove, *Phys. Rev. B* 17, 1510 (1978).
1614. D. L. Adams, H. B. Nielsen and M. A. Van Hove, *Phys. Rev. B* 20, 4789 (1979).
1615. R. H. Tait and R. V. Kasowski, *Phys. Rev. B* 20, 5178 (1979).
1616. S. C. Fain, Jr., M. D. Chinn and R. D. Diehl, *Phys. Rev. B* 21, 4170 (1980).
1617. D. W. Jepsen, H. D. Shih, F. Jona and P. M. Marcus, *Phys. Rev. B* 22, 814 (1980).
1618. R. J. Meyer, C. B. Duke, A. Paton, J. C. Tsang, J. L. Yeh, A. Kahn and P. Mark, *Phys. Rev. B* 22, 6171 (1980).
1619. C. B. Duke, A. Paton, W. K. Ford, A. Kahn and J. Carelli, *Phys. Rev. B* 24, 562 (1981).
1620. C. B. Duke, A. Paton, W. K. Ford, A. Kahn and G. Scott, *Phys. Rev. B* 24, 3310 (1981).
1621. F. Soria, V. Martinez, M. C. Munoz and J. L. Sacedon, *Phys. Rev. B* 24, 6926 (1981).
1622. A. K. Green and E. Bauer, *J. Appl. Phys.* 52, 5098 (1981).
1623. P. Hahn, J. Clabes and M. Henzler, *J. Appl. Phys.* 51, 2079 (1980).
1624. C. Oshima, M. Aono, T. Tanaka, R. Nishitani and S. Kawai, *J. Appl. Phys.* 51, 997 (1980).
1625. M. Aono, C. Oshima, T. Tanoka, E. Bannai and S. Kawai, *J. Appl. Phys.* 49, 2761 (1978).
1626. S. A. Isa, R. W. Joyner and M. W. Roberts, *J. Chem. Soc. Faraday Trans. I* 74, 546 (1978).

1627. J. C. Bertolini, J. Massardier and G. Dalmai-Imelik, *J. Chem. Soc. Faraday Trans. I* 74, 1720 (1978).
1628. G. Le Lay, *J. Crystal Growth* 54, 501 (1981).
1629. M. Grunze, W. Hirschwald and D. Hofmann, *J. Cryst. Growth* 52, 241 (1981).
1630. K. Nii, K. Yoshihara, *J. Jpn. Inst. Met.* 44, 100 (1980).
1631. C. Oshima, M. Oano, S. Zaima, Y. Shibata and S. Kawai, *J. Less-Common Met.* 82, 69 (1981).
1632. A. Landet, M. Jardinier-Offergeld and F. Bouillon, *J. Microsc. and Spectrosc. Electron* 30, 101 (1978).
1633. C. Benndorf, B. Egert, G. Keller, H. Seidel and F. Thieme, *J. Phys. Chem. Solids* 40, 877 (1979).
1634. L. Morales, D. O. Garza and L. J. Clarke, *J. Phys. C* 14, 5391 (1981).
1635. S. P. Tear, K. Roll and M. Prutton, *J. Phys. C* 14, 3297 (1981).
1636. J. C. Fernandez, W. S. Yang, H. D. Shih, F. Jona, P. W. Jepsen and P. M. Marcus, *J. Phys. C* 14, L55 (1981).
1637. F. Jona and P. M. Marcus, *J. Phys. C* 13, L477 (1980).
1638. M. R. Welton-Cook and M. Prutton, *J. Phys. C* 13, 3993 (1980).
1639. H. D. Shih, F. Jona, U. Bardi and P. M. Marcus, *J. Phys. C* 13, 3801 (1980).
1640. F. Jona, D. Sondericker and P. M. Marcus, *J. Phys. C* 13, L155 (1980).
1641. M. Prutton, J. A. Ramsey, J. A. Walker and M. R. Welton-Cook, *J. Phys. C* 12, 5271 (1979).
1642. W. T. Moore, P. R. Watson, D. C. Frost and K. A. R. Mitchell, *J. Phys. C* 12, L887 (1979).
1643. K. Griffiths and D. A. King, *J. Phys. C* 12, L755 (1979).
1644. T. Matsudaira and M. Onchi, *J. Phys. C* 12, 3381 (1979).
1645. F. Jona, H. D. Shih, D. W. Jepsen and P. M. Marcus, *J. Phys. C* 12, L455 (1979).
1646. R. Feder, W. Monch and P. P. Auer, *J. Phys. C* 12, L179 (1979).
1647. A. Ignatiev, H. B. Nielsen and D. L. Adams, *J. Phys. C* 11, L837 (1978).
1648. F. R. Shepherd, P. R. Watson, D. C. Frost and K. A. R. Mitchell, *J. Phys. C* 11, 4591 (1978).
1649. Y. Fujinaga, *J. Vac. Soc. JPN* 23, 253 (1980).
1650. Y. Terada, T. Yoshizuka, K. Oura and T. Hanawa, *JPN, J. Appl. Phys.* 20, L333 (1981).
1651. M. G. Lagally, T. M. Lu and G. C. Wang, "Ordering in Two Dimensions," Proceedings of an International Conference on Ordering in Two Dimensions, P 113 (1981).
1652. R. L. Park, T. L. Einstein, A. R. Kortan and L. D. Roelofs, "Ordering in Two Dimensions," Proceedings of an International Conference on Ordering in Two Dimensions, P17 (1981).
1653. Y. J. Chabal and J. E. Rowe, *Ibid*, P251 (1981).
1654. R. Ducros, M. Housley and G. Piquard, *Phys. Status Solidi A* 56, 187 (1979).
1655. W. Arabczyk, H. J. Mussig and F. Storbeck, *Phys. Status Solidi A* 55, 437 (1979).
1656. R. Feder and J. Kirschner, *Phys. Status Solidi A* 45, K117 (1978).
1657. V. K. Medvedev and V. N. Pogoreli, *UKR Fiz. Zh.* 25, 1524 (1980).
1658. K. Christmann, *Z. Naturforsch. A* 34A, 22 (1979).
1659. K. C. R. Chiu, J. M. Paate, J. E. Rowe, T. T. Sheng and A. G. Cullis, *Appl. Phys. Lett.* 38, 988 (1981).
1660. V. Montgomery, R. H. Williams and R. R. Varma, *J. Phys. C* 11, 1989 (1978).
1661. K. J. Rawlings, M. J. Gibson and P. J. Dobson, *J. Phys. D* 11, 2059 (1978).
1662. A. A. Galaev, L. V. Gamosov, Yu N. Parkhomenko and A. V. Shirkov, *Sov. Phys. Crystallogr.* 24, 72 (1979).
1663. S. Ferrer, L. Gonzalez, M. Salmeron, J. A. Verges and F. Ndurain, *Solid State Commun.* 38, 317 (1981).
1664. W. Erley and H. Ibach, *Solid State Commun.* 37, 937 (1981).
1665. C. M. Chan, M. A. Van Hove, W. H. Weinberg and E. D. Williams, *Solid State Commun.* 30, 47 (1979).
1666. M. A. Van Hove, G. Ertl, K. Christmann, R. J. Behm and W. H. Weinberg, *Solid State Commun.* 28, 373 (1978).
1667. J. Behm, K. Christmann and G. Ertl, *Solid State Commun.* 25, 763 (1978).
1668. R. A. Barker, P. J. Estrup, F. Jona, and P. M. Marcus, *Solid State Commun.* 25, 375 (1978).
1669. V. G. Lifshits, V. B. Akilov and Y. L. Gavriljuk, *Solid State Commun.* 40, 429 (1981).
1670. P. Legare, Y. Holl and G. Maire, *Solid State Commun.* 31, 307 (1979).
1671. H. Namba, J. Darville, J. M. Gilles, *Solid State Commun.* 34, 287 (1980).
1672. R. Courths, *Phys. Status Solidi B* 100, 135 (1980).
1673. J. H. Onuferko, PHD Thesis, Univ. Warwick Coventry, England.
1674. I. F. Lyuksyutov and A. G. Fedorus, *Zh. Eksp. and Teor. Fiz.* 80, 2511 (1981).
1675. F. Lyuksyutov, V. K. Medvedev and I. N. Yakovkin, *Zh. Eksp. and Teor. Fiz.* 80, 2452 (1981).

1676. V. P. Ivanov, V. I. Savchenko and V. L. Tataurov, *Sov. Phys. Tech. Phys.* 26, 237 (1981).
1677. B. M. Zykov, V. K. Tskhakaya, *Sov. Phys. Tech. Phys.* 24, 948 (1979).
1678. A. Gutmann and K. Hayek, *Thin Solid Films* 58, 145 (1979).
1679. K. Christmann, G. Ertl and H. Shimizu, *Thin Solid Films* 57, 247 (1979).
1680. M. G. Barthes and A. Rolland, *Thin Solid Films* 76, 45 (1981).
1681. B. Gruzza and E. Gillet, *Thin Solid Films* 68, 345 (1980).
1682. C. Argile and G. E. Rhead, *Thin Solid Films* 67, 299 (1980).
1683. B. Z. Olshanetskii, V. I. Mashanov and A. I. Nikiforov, *Sov. Phys. Solid State* 23, 1505 (1981).
1684. M. S. Gupalo, V. K. Medvedev, B. M. Palyukh and T. P. Smereka, *Sov. Phys. Solid State* 22, 1873 (1980).
1685. B. Z. Olshanetskii and V. I. Mashanov, *Sov. Phys. Solid State* 22, 1705 (1980).
1686. M. Weiss, G. Ertl and F. Nitschke, *Appl. Surf. Sci.* 2, 614 (1979).
1687. J. Küppers and H. Mitchel, *Appl. Surf. Sci.* 3, 179 (1979).
1688. K. H. Rieder, *Appl. Surf. Sci.* 4, 183-9 (1980).
1689. H. Geiger and P. Wissmann, *Appl. Surf. Sci.* 5, 153 (1980).
1690. G. Ronida, F. Pratesi and E. Ferroni, *Appl. Surf. Sci.* 5, 121 (1980).
1691. S. A. Isa, R. W. Joyner, M. H. Matloob and M. Wyn Roberts, *Appl. Surf. Sci.* 5, 345 (1980).
1692. D. G. Castner and G. A. Somorjai, *Appl. Surf. Sci.* 6, 29 (1980).
1693. K. Khonde, J. Darville, S. E. Donnelly and J. M. Gilles, *Appl. Surf. Sci.* 6, 297 (1980).
1694. E. Bechtold, *Appl. Surf. Sci.* 7, 231 (1981).
1695. O. Oda, L. J. Harrekamp and G. A. Bootsma, *Appl. Surf. Sci.* 7, 206 (1981).
1696. G. Le Lay A. Chauvet, M. Manneville and R. Kern, *Appl. Surf. Sci.* 9, 190 (1981).
1697. G. Vidali, M. W. Cole, W. H. Weinberg, and W. A. Steele, *Phys. Rev. Lett.* 51, 118 (1983).
1698. M. Maglietta, *Solid State Comm.* 43, 395 (1982).
1699. R. J. Baird, D. F. Ogletree, M. A. Van Hove, and G. A. Somorjai *Surface Sci.* 165, 345 (1986).
1700. J. Sokolov, F. Jona, and P. M. Marcus, *Phys. Rev. B*, 1397 (1986).
1701. H. D. Shih, F. Jona, and P. M. Marcus, *Surface Sci.* 104, 39 (1981).
1702. S. Y. Tong, W. M. Mei, and G. Xu, *J. Vac. Sci. Tech. B* 2, 393 (1984).
1703. G. Xu, W. Y. Hu, M. W. Puga, S. Y. Tong, J. L. Yeh, S. R. Wang and B. W. Lee, *Phys. Rev. B* 32, 8473 (1985).
1704. P. H. Citrin, J. E. Rowe and P. Eisenberger, *Phys. Rev. B* 28, 2299 (1983).
1705. C. M. Chan, S. L. Cunningham, M. A. Van Hove, W. H. Weinberg, and S. P. Withrow, *Surface Sci.* 66, 394 (1977).
1706. B. J. Mrstik, R. Kaplan, T. L. Reinecke, M.A. Van Hove, and S. Y. Tong, *Phys. Rev. B* 15, 897 (1977).
1707. J. E. Demuth, P.M. Marcus, and D. W. Jepsen, *Phys. Rev. B* 11, 1460 (1975).
1708. D. H. Rosenblatt, S. D. Kevan, J. G. Tobin, R. F. Davis, M. G. Mason, D. R. Denley, D. A. Shirley, Y. Huang, and S. Y. Tong, *Phys. Rev. B* 26, 1812 (1982).
1709. Y. Kuk, L. C. Feldman, and P.J. Silverman, *Phys. Rev. Lett.* 50, 511 (1983).
1710. F. Maca, M. Scheffler, and W. Berndt, *Surface Sci.* 160, 467 (1985).
1711. D. F. Ogletree, M. A. Van Hove, and G. A. Somorjai, *Surface Sci.* 173, 351 (1986).
1712. K. Hayek, H. Glassl, A. Gutmann, H. Leonhard, P. Prutton, S. P. Tear, and M.R. Welton-Cook, *Surface Sci.* 152, 419 (1985).
1713. M. A. Van Hove, R. J. Koestner, in *Surface Structure by LEED*, ed. P. M. Marcus and F. Jona, Plenum, New York (1984).
1714. L. Smit, R. M. Tromp, and J. F. Van der Veen, *Surface Sci.* 163, 315 (1985).
1715. P. H. Citrin, J. E. Rowe, and P. Eisenberger, *Phys. Rev. B* 28 2299 (1983).
1716. G. J. Jones, and B. W. Holland, *Solid State Comm.* 53, 45 (1985).
1717. H. D. Shih, F. Jona, D. W. Jepsen, and P. M. Marcus, *J. Phys. C* 9, 1405 (1976).
1718. K. C. Hui, R. H. Milne, K. A. R. Mitchell, W. T. Moore, and M. Y. Zhou, *Solid State Comm.* 56, 83 (1985).
1719. M. J. Cardillo, G. E. Becker, D. R. Hamann, J. A. Serri, L. Whitman, and L. F. Mattheiss, *Phys. Rev. B* 28, 494 (1983).
1720. M. A. Van Hove, S. Y. Tong, and N. Stoner, *Surface Sci.* 54, 259 (1976).
1721. Groupe d'Etude des Surfaces, *Surface Sci.* 62, 567 (1977).
1722. E. Lang, W. Grimm, and K. Heinz, *Surface Sci.* 117, 169 (1982).
1723. H. L. Davis, R. J. Noonan, *Surface Sci.* 126, 245 (1983).
1724. F. Jona, D. Westphal, A. Goldman, and P. M. Marcus, *J. Phys. C* 16, 3001 (1983).

1725. E. L. Bullock, C. S. Fadley, and P. J. Orders, *Phys. Rev. B* 28, 4867 (1983).
1726. J. G. Tobin, L. E. Klebanoff, D. H. Rosenblatt, R. F. Davis, E. Umbach, A. G. Baca, D. A. Shirley, Y. Huang, W. M. Kang, and S. Y. Tong, *Phys. Rev. B* 26, 7076 (1982).
1727. U. Döbler, K. Baberschke, J. Stör, and D. A. Outka, *Phys. Rev. B* 31, 2532 (1985).
1728. F. Comin, P. H. Citrin, P. Eisenberger, and J. E. Rowe, *Phys. Rev. B* 26, 7060 (1982).
1729. K. O. Legg, F. Jona, D. W. Jepsen, and P. M. Marcus, *J. Phys. C* 10, 937, (1977).
1730. A. Ignatiev, F. Jona, D. W. Jepsen, and P. M. Marcus, *Phys. Rev. B* 11, 4780 (1975).
1731. S. A. Lindgren, J. Paul, L. Wallden, and P. Westrin, *J. Phys. C* 15, 6285 (1982).
1732. M. A. Van Hove, and S. Y. Tong, *J. Vac. Sci. Tec.* 12, 230 (1975).
1733. D. H. Rosenblatt, S. D. Kevan, J. G. Tobin, R. F. Davis, M. G. Mason, D. A. Shirley, J. C. Tang, and S. Y. Tong, *Phys. Rev. B* 26, 3181 (1982).
1734. J. J. Barton, C. C. Bahr, Z. Hussain, S. W. Robey, L. E. Klebanoff and D. A. Shirley, *J. Vac. Sci. Tech. A* 2, 847 (1984).
1735. P. J. Orders, B. Sinkovic, C. S. Fadley, R. Trehan, Z. Hussain, and J. Lecante, *Phys. Rev. B* 30, 1838 (1984).
1736. J. Stöhr, R. Jaeger, and S. Brennan, *Surf. Sci.* 117, 503 (1982).
1737. J. E. Demuth, D. W. Jepsen, and P. M. Marcus, *J. Phys. C* 8, L25 (1975).
1738. J. Stöhr, R. Jaeger, and T. Kendelewicz, *Phys. Rev. Lett.* 49, 142 (1982).
1739. J. W. M. Frenken, J. F. Van der Veen, and G. Allan, *Phys. Rev. Lett.* 51, 1876 (1983).
1740. M. de Crescenzi, F. Antonangeli, C. Bellini, and R. Rosei, *Phys. Rev. Lett.* 50, 1949 (1983).
1741. S. Y. Tong, W. M. Kang, D. H. Rosenblatt, J. G. Tobin, and D. A. Shirley, *Phys. Rev. B* 27, 4632 (1983).
1742. T. S. Rahman, D. L. Mills, J. E. Black, J. M. Szeftel, S. Lehwald and H. Ibach, *Phys. Rev. B* 30, 589 (1984).
1743. D. Norman, J. Stöhr, R. Jaeger, P. J. Durham, and J. B. Pendry, *Phys. Rev. Lett.* 51, 2052 (1983).
1744. J. E. Demuth, D. W. Jepsen, and P. M. Marcus, *J. Phys. C* 6, L307 (1973).
1745. R. Feder, *Surface Sci.* 68, 229 (1977).
1746. B. W. Holland, C. D. Duke, and A. Paton, *Surface Sci.* 140, L269 (1984).
1747. M. A. Passler, A. Ignatiev, B. W. Lee, D. Adams, M. A. Van Hove, in *Determination of Surface Structure by LEED*, Plenum, New York (1984).
1748. K. Griffiths, D. A. King, G. C. Aers, and J. B. Pendry, *J. Phys. C* 15, 4921 (1982).
1749. K. Heinz, D. K. Saldin, and J. B. Pendry, *Phys. Rev. Lett.* 55, 2312 (1985).
1750. Y. Kuk, and L. C. Feldman, *Phys. Rev. B* 30, 5811 (1984).
1751. A. Puschmann, and J. Haasse, *Surface Sci.* 144, 559 (1984).
1752. W. Moritz, and D. Wolf, *Surface Sci.* 163, L655 (1985).
1753. W. Moritz, R. Imbihl, R. J. Behm, G. Ertl, and T. Matsushima, *J. Chem. Phys.* 83, 1959 (1985).
1754. P. M. Echenique, *J. Phys. C* 9, 3193 (1976).
1755. S. Andersson, J. B. Pendry, and P. M. Echenique, *Surface Sci.* 65, 539 (1977).
1756. D. L. Adams, L. E. Peterson, and C. S. Sorenson, *J. Phys. C* 18, 1753 (1985).
1757. M. L. Xu, and S. Y. Tong, *Phys. Rev. B* 31, 6332 (1985).
1758. E. Tornquist, E. D. Adams, M. Copel, T. Gustafsson, and W. R. Graham, *J. Vac. Sci. Tech. A* 2, 939 (1984).
1759. R. Baudoing, Y. Gauthier, and Y. Joly, *J. Phys. C* 18, 4061 (1985).
1760. C. J. Barnes, M. Q. Ding, M. Lindroos, R. D. Diehl, and D. A. King, *Surface Sci.* 162, 59 (1985).
1761. H. Niehus, *Surface Sci.* 145, 407 (1984).
1762. D. L. Adams, and H. B. Nielsen, *Surface Sci.* 116, 598 (1982).
1763. M. A. Van Hove, and S. Y. Tong, *Surface Sci.* 54, 91 (1976).
1764. C. B. Duke, and A. Paton, *J. Vac. Sci. Tech. B* 2, 327 (1984).
1765. H. J. Grossman, and M. W. Gibson, *J. Vac. Sci. Tech. B* 2, 343 (1984).
1766. L. Smit, R. M. Tromp, and J. F. Van der Veen, *Phys. Rev. B* 29, 4814 (1984).
1767. J. Sokolov, F. Jona, and P. M. Marcus, *Phys. Rev. B* 31, 1929 (1985).
1768. P. C. Wong, M. Y. Zhou, K. C. Hui, and K. A. R. Mitchell, *Surface Sci.* 163, 172 (1985).
1769. A. Ignatiev, B. W. Lee, M. A. Van Hove, in *Proceedings of the 7th International Vacuum Congress and 3rd International Conference on Solid Surfaces*, Vienna (1977).
1770. W. S. Yang, F. Jona, and P. M. Marcus, *Phys. Rev. B* 28, 7377 (1983).
1771. H. L. Davis and J. R. Noonan, *Phys. Rev. Lett.* 54, 566 (1985).
1772. C. B. Duke, A. R. Lubinsky, B. W. Lee, and P. Mark, *J. Vac. Sci. Tech.* 13, 761 (1976).

1773. A. R. Lubinsky, C. B. Duke, S. C. Chang, B. W. Lee, and P. Mark *J. Vac. Sci. Tech.* 13, 189 (1976).
1774. D. Norman, S. Brennan, R. Jaeger and J. Stöhr, *Surface Sci.* 105, L297 (1981).
1775. R. Z. Bachrach, G. V. Hansson and R. S. Bauer, *Surface Sci.* 109, L560 (1981).
1776. M. Maglietta, E. Zanazzi, F. Jona, D. W. Jepsen and P. M. Marcus, *Applied Physics* 15, 409 (1978).
1777. M. Maglietta, E. Zanazzi, U. Bardi and F. Jona, *Surface Sci.* 77, 101 (1978).
1778. R. C. Felton, M. Prutton, S. P. Tear and M. R. Welton-Cook, *Surface Science* 88, 474 (1979).
1779. P. H. Citrin, P. Eisenberger and R. C. Hewitt, *Physical Review Letters* 45, 1948 (1980).
1780. S. Andersson and J. B. Pendry, *Journal of Physics C* 13, 2547 (1980).
1781. J. Onuferko and D. P. Woodruff, *Surface Science* 95, 555 (1980).
1782. R. W. Streater, W. T. Moore, P. R. Watson, D. C. Frost and K. A. R. Mitchell, *Surface Sci.* 72, 744 (1978).
1783. P. Eisenberger and W. C. Marra, *Physical Review Letters* 46, 1081 (1981).
1784. S. P. Tear, M. R. Welton-Cook, M. Prutton and J. A. Walker, *Surface Science* 99, 598 (1980).
1785. M. A. Van Hove, R. J. Koestner, P. C. Stair, J. P. Biberian, L. L. Kesmodel, I. Bartos and G. A. Somorjai, *Surface Sci.* 103, 218 (1981).
1786. C. M. Chan, S. M. Cunningham, K. L. Luke, W. H. Weinberg and S. P. Withrow, *Surface Sci.* 78, 15 (1978).
1787. C. M. Chan, M. A. Van Hove, W. H. Weinberg and E. D. Williams, *Journal of Vacuum Science and Technology* 16, 642 (1979).
1788. C. M. Chan, K. L. Luke, M. A. Van Hove, W. H. Weinberg and S. P. Withrow, *Surface Sci.* 78, 386 (1978).
1789. S. Y. Tong, A. Maldonado, C. H. Li and M. A. Van Hove, *Surface Sci.* 94, 73 (1980).
1790. S. Andersson and J. B. Pendry, *Journal of Physics C* 13, 3547 (1980).
1791. L. G. Petersson, S. Kono, N. F. T. Hall, C. S. Fadley and J. B. Pendry, *Physical Review Letters* 42, 1545 (1979).
1792. Y. Gauthier, D. Aberdam and R. Baudoing, *Surface Sci.* 78, 339 (1978).
1793. D. H. Rosenblatt, J. G. Tobin, M. G. Mason, R. F. Davis, S. D. Kevan, D. A. Shirley, C. H. Li and S. Y. Tong, *Physical Review B* 23, 3828 (1981).
1794. T. Narasawa, W. M. Gibson and E. Tornquist, *Physical Review Letters* 47, 417 (1981).
1795. S. D. Kevan, R. F. Davis, D. H. Rosenblatt, J. G. Tobin, M. G. Mason, D. A. Shirley, C. H. Li and S. Y. Tong, *Physical Review Letters* 46, 1629 (1981).
1796. T. Narasawa and W. M. Gibson, *Surface Science* 114, 331 (1981).
1797. R. J. Behm, K. Christmann, G. Ertl and M. A. Van Hove, *Journal of Chemical Physics* 73, 2984 (1980).
1798. J. A. Davies, T. E. Jackman, D. P. Jackson and P. R. Norton, *Surface Science* 109, 20 (1981).
1799. R. Feder, H. Pleyer, P. Bauer and N. Müller, *Surface Sci.* 109, 419 (1981).
1800. S. Hengrasme, A. R. Mitchell, P. R. Watson and S. J. White, *Canadian Journal of Physics* 58, 200 (1980).
1801. R. J. Meyer, W. R. Salaneck, C. B. Duke, A. Paton, C. H. Griffiths, L. Kovnat and L. E. Meyer, *Physical Review B* 21, 4542 (1980).
1802. F. S. Marsh, M. K. Debe and D. A. King, *Journal of Physics C* 13, 2799 (1980).
1803. W. A. Jesser and J. W. Matthews, *Acta Metall.* 16, 1307 (1968).
1804. A. Chambers and D. C. Jackson, *Phil. Mag.* 31, 1357 (1975).
1805. J. W. Matthews, *Thin Solid Films* 12, 243 (1972).
1806. J. W. Matthews, *Phil. Mag.* 13, 1207 (1966).
1807. K. Yagi, K. Takanayagi, K. Kobayashi and G. Honjo, *J. Crystal. Growth* 9, 84 (1971).
1808. W. A. Jesser and J. W. Matthews, *Phil. Mag.* 17, 595 (1968).
1809. W. A. Jesser and J. W. Matthews, *Phil. Mag.* 15, 1097 (1967).
1810. W. A. Jesser and J. W. Matthews, *Phil. Mag.* 17, 461 (1968).
1811. A. I. Fedorenko and R. Vincent, *Phil. Mag.* 24, 55 (1971).
1812. R. Kuntze, A. Chambers and M. Prutton, *Thin Solid Films* 4, 47 (1969).
1813. U. Gradmann, *Ann. Physik.* 13, 213 (1964).
1814. U. Gradmann, *Ann. Physik.* 17, 91 (1966).
1815. R. W. Vook, C. T. Horng and J. E. Macur, *J. of Crystal Growth* 31, 353 (1975).
1816. R. W. Vook and C. T. Horng, *Phil. Mag.* 33, 843 (1976).
1817. C. T. Horng and R. W. Vook, *Surface Sci.* 54, 309 (1976).
1818. U. Gradmann, *Phys. Kondens. Materie* 3, 91 (1964).

1819. R. W. Vook and J. E. Macur, *Thin Solid Films* 32, 199 (1976).
1820. L. A. Bruce, H. Jaeger, *Phil. Mag.* 36, 1331 (1977).
1821. C. Gonzalez, *Acta Met.* 15, 1373 (1967).
1822. C. T. Horng and R. W. Vook, *J. Vac. Sci. Technol.* 11, 140 (1974).
1823. E. Grhnbaum, G. Kremer and C. Reymond, *J. Vac. Sci. Technol.* 6, 475 (1969).
1824. R. C. Newman and D. W. Pashley, *Phil. Mag.* 46, 927 (1955).
1825. F. Soria, J. L. Sacedon, P. M. Echenique and D. Titterington, *Surface Sci.* 68, 448 (1977).
1826. M. Klaua and H. Bethce, *J. of Crystal Growth* 3, 4 188 (1968).
1827. E. Grunbaum, *Proc. Phys. Soc. (London)* 72, 459 (1958).
1828. E. F. Wassermann and H. P. Jablonski, *Surface Sci.* 22, 69 (1970).
1829. D. C. Hothersall, *Phil. Mag.* 15, 1023 (1967).
1830. P. Gueguen, C. Camoin and M. Gillet, *Thin Solid Films* 26, 107 (1975).
1831. G. Honjo, K. Takayanagi, K. Kobayashi and K. Yagi, *J. of Crystal Growth* 42, 98 (1977).
1832. P. Gueguen, M. Cahareau and M. Gillet, *Thin Solid Films* 16, 27 (1973).
1833. D. Cherns and M. J. Stowell, *Thin Solid Films* 29, 107 (1975).
1834. D. Cherns and M. J. Stowell, *Thin Solid Films* 29, 127 (1975).
1835. W. A. Jesser, J. W. Matthews and D. Kuhlmann-Wilsdorf, *Appl. Phys. Lett.* 9, 176 (1966).
1836. J. E. Macur and R. W. Vook, 32nd Ann. Proc. Electron Microscopy Soc. Amer., St. Louis, Missouri, 1974, C. J. Arceneaux (ed.).
1837. J. E. Macur, 33rd Ann. Proc. Electron Microscopy Soc. Amer., Las Vegas, Nevada, 1975, B. W. Bailey (ed.), p. 98.
1838. J. W. Matthews, *Phys. Thin Films* 4, 137 (1967).
1839. G. Dorey, *Thin Solid Films* 5, 69 (1970).
1840. A. Mlynczak and R. Niedermayer, *Thin Solid Films* 28, 37 (1975).
1841. P. W. Steinhage and H. Mayer, *Thin Solid Films* 28, 131 (1975).
1842. C. M. Mate and G. A. Somorjai, *Surface Sci.* 160, 542 (1985).
1843. S. Thomas and T. W. Haas, *Surface Sci.* 28, 632 (1971).
1844. C. M. Mate, B. E. Bent and G. A. Somorjai, *J. of Electron. Spectrosc. Related Phenom.* 39, 205 (1986).
1845. P. I. Cohen, J. Unguris, and M. B. Webb, *Surface Sci.* 58, 429 (1976).
1846. N. J. Wu and A. Ignatiev, *Phys. Rev. B* 25, 2983 (1982).
1847. N. J. Wu and A. Ignatiev, *Phys. Rev. B* 28, 7288 (1983).
1848. M. Weltz, W. Moritz, and D. Wolf, *Surface. Sci.* 125, 473 (1983).
1849. D. A. Outka, R. J. Madix, and J. Stöhr, *Surface Sci.* 164, 235 (1985).
1850. A. Puschman, J. Hasse, M. D. Crapper, C. E. Riley, and D. P. Woodruff, *Phys. Rev. Lett.* 54, 2250 (1985).
1851. D. Sondericker, F. Jona, and P. M. Marcus, *Phys. Rev. B* 33, 900 (1986).
1852. J. Stöhr, E. B. Kollin, D. A. Fischer, J. B. Hastings, F. Zaera, and F. Sette, *Phys. Rev. Lett.* 55, 1468 (1985).
1853. J. F. Van der Veen, R. M. Tromp, R. G. Smeenk, and F. W. Saris, *Surface Sci.* 82, 468 (1979).
1854. D. F. Ogletree, M. A. Van Hove, and G. A. Somorjai, *Surface Sci.* 183, 1 (1987).
1855. R. F. Lin, G. S. Blackman, A. M. Van Hove, and G. A. Somorjai, *Acta Crystallographica B*, in press (1987).
1856. M. A. Van Hove, R. F. Lin, and G. A. Somorjai, *J. Am. Chem. Soc.* 108, 2532 (1986).
1857. P. H. Citrin, P. Eisenberger, and J. E. Rowe, *Phys. Rev. Lett.* 48, 802 (1982).
1858. G. Materlik, A. Frohm, and M. J. Bedzyk, *Phys. Rev. Lett.* 52, 441 (1984).
1859. J. A. Golovchenko, J. R. Patel, D. R. Kaplan, P. L. Cowan, and M. J. Bedzyk, *Phys. Rev. Lett.* 49, 1560 (1982).
1860. E. J. Van Loenen, J. W. M. Frenken, J. F. Van der Veen, and S. Valeri, *Phys. Rev. Lett.* 54, 827 (1985).
1861. H. Ohtani, M. A. Van Hove, and G. A. Somorjai, *Surface Sci.*, in press (1987).
1862. H. Ohtani, M. A. Van Hove, and G. A. Somorjai, unpublished results.
1863. C. B. Duke, A. Paton, A. Kahn, and C. R. Bonapace, *Phys. Rev. B* 28, 852 (1983).
1864. J. E. Demuth, P. M. Marcus, and D. W. Jepsen, *Phys. Rev. B* 11, 1460 (1975).
1865. S. Anderson and J. B. Pendry, *Sol. St. Comm.* 16, 563 (1975).
1866. D. H. Rosenblatt, S. D. Kevan, J. G. Tobin, R. F. Davis, M. G. Mason, D. R. Denley, D. A. Shirley, Y. Huang, and S. Y. Tong, *Phys. Rev. B* 26, 1812 (1982).

1867. M. A. Van Hove and S. Y. Tong, *J. Vac. Sci. Tech.* 12, 230 (1975).
1868. D. Sondericker, F. Jona, and P. M. Marcus, *Phys. Rev.* B33, 900 (1986).
1869. P. H. Citrin, D. R. Hamann, L. F. Mattheiss, and J. E. Rowe, *Phys. Rev. Lett.* 49, 1712 (1982).
1870. W. N. Unertl and H. V. Thapliyal, *J. Vac. Sci. Technol.* 12, 263 (1975).
1871. A. Kahn, J. Carelli, D. Kanani, C. B. Duke, A. Paton, L. Brillson, *J. Vac. Sci. Tech.* 19, 331 (1981).
1872. J. R. Noonan and H. R. Davis, *Vacuum* 31, 107 (1982).
1873. E. Zanazzi and F. Jana, *Surf. Sci.* 62, 61 (1977).
1874. J. F. Van der Veen, R. G. Smeenk, R. M. Tromp, and F. M. Saris, *Surf. Sci.* 79, 219 (1979).
1875. C. M. Chan and M. A. Van Hove, unpublished results.
1876. C. M. Mate, C.-T. Kao and G. A. Somorjai, unpublished results.
1877. G. S. Blackman, C.-T. Kao, R. J. Koestner, B. E. Bent, C. M. Mate, M. A. Van Hove, and G. A. Somorjai, unpublished results.
1878. A. L. Slavin, B. E. Bent, C.-T. Kao and G. A. Somorjai, unpublished results.
1879. B. E. Bent, C.-T. Kao and G. A. Somorjai, unpublished results.
1880. C.-T. Kao, B. E. Bent and G. A. Somorjai, unpublished results.
1881. C.-T. Kao, C. M. Mate, B. E. Bent and G. A. Somorjai, unpublished results.
1882. C. G. Shaw, S. C. Fain, Jr., and M. D. Chinn, *Phys. Rev. Lett.* 41, 955 (1978).
1883. S. C. Fain, Jr., M. F. Torey, R. D. Diehl, *Proc. 9th Intern. Vacuum Congr. & 5th Int. Conf. Solid Surfaces* (Madrid, 1983), ed. by J. L. de Segovia, p. 129.
1884. B. E. Koel, J. E. Crowell, C. M. Mate, and G. A. Somorjai, *J. Phys. Chem.* 88, 1988 (1984).
1885. W. T. Moore, S. J. White, D. C. Frost, and K. A. R. Mitchell, *Surf. Sci.* 116, 253 (1982).
1886. W. T. Moore, S. J. White, D. C. Frost, and K. A. R. Mitchell, *Surf. Sci.* 116, 261 (1982).
1887. S. Andersson and J. B. Pendry, *J. Phys. C* 9, 2721 (1976).
1888. R. J. Meyer, C. B. Duke, A. Paton, J. L. Yeh, J. C. Tsung, A. Kahn, and P. Mark, *Phys. Rev. B* 21, 4740 (1980).
1889. H. Melle and E. Menzel, *Z. Naturforsch.* 33a, 282 (1978).
1890. H. Niehus, *Surf. Sci.* 145, 407 (1984).
1891. S. Lehwald, H. Ibach, and J. E. Demuth, *Surf. Sci.* 78, 577 (1978).
1892. B. E. Koel, J. E. Crowell, C. M. Mate, and G. A. Somorjai, *J. Phys. Chem.* 88, 1988 (1984).
1893. W. T. Moore, S. J. White, D. C. Frost, and K. A. R. Mitchell, *Surface Sci.* 116, 253 (1982).
1894. F. Frostmann, *Japn. J. Appl. Phys., Suppl.* 2 Part 2, 657 (1974).
1895. N. Stoner, Ph.D. Thesis, University of Wisconsin, Milwaukee (1976).
1896. F. Soria, J. L. Sacedon, P. M. Echenique, D. Titterton, *Surf. Sci.* 68, 448 (1977).
1897. D. W. Jepsen, P. M. Marcus, F. Jona, *Phys. Rev. B* 5, 3933 (1972).
1898. D. W. Jepsen, P. M. Marcus, F. Jona, *Phys. Rev. B* 8, 5523 (1973).
1899. W. Moritz, Ph.D. Thesis, University of Munich (1976).
1900. J. A. Strozier, R. O. Jones, *Phys. Rev. B* 3, 3228 (1971).
1901. J. A. Strozier, R. O. Jones, *Phys. Rev. Lett.* 25, 516 (1970).
1902. H. D. Shih, F. Jona, D. W. Jepsen, P. M. Marcus, *Commun. Phys.* 1, 25 (1976).
1903. C. G. Shaw, S. C. Fain, M. D. Chinn, M. F. Toney, *Surface Sci.* 97, 128 (1980).
1904. C. Bouldin, E. A. Stern, *Phys. Rev. B* 25, 3462 (1982).
1905. F. Comin, P. H. Citrin, P. Eisenberger, J. E. Rowe, *Phys. Rev. B* 26, 7060 (1982).
1906. J. Bohr, R. Feidenhansl, M. Nielsen, M. Toney, R. L. Johnson, and I. K. Robinson, *Phys. Rev. Lett.* 54, 1275 (1985).
1907. R. Rosei, M. de Crescenzi, F. Sette, C. Quaresima, A. Savoia, P. Perfetti, *Phys. Rev. B* 28, 1161 (1983).
1908. R. G. Jones, S. Ainsworth, M. D. Crapper, C. Somerton, D. P. Woodruff, R. S. Brooks, J. C. Cam-puzano, D. A. King, G. M. Lamble, *Surf. Sci.* 152/153, 443 (1985).
1909. Y. Gauthier, R. Baudoing, Y. Joly, J. Rundgren, J. C. Bertolini, and J. Massardier, *Surf. Sci.* 162, 342 (1985).
1910. M. Saitoh, F. Shoji, K. Oura, T. Hanawa, *Jap. J. Appl. Phys.* 19, L421 (1980).
1911. J. Stöhr, R. Jaeger, G. Rossi, T. Kendelewicz, I. Lindau, *Surf. Sci.* 134, 813 (1983).
1912. A. Ignatiev, T. N. Rhodin, S. Y. Tong, B. I. Lundqvist, J. B. Pendry, *Solid State Commun.* 9, 1851 (1971).
1913. L. J. Clarke, *Surf. Sci.* 102, 331 (1981).
1914. A. Ignatiev, J. B. Pendry, T. N. Rhodin, *Phys. Rev. Lett.* 26, 189 (1971).
1915. P. H. Citrin, *Bull. Am. Phys. Soc.* 25, 383 (1980).
1916. A. G. J. de Wit, R. P. N. Bronckers, Th. M. Hupkens, J. M. Fluit, *Surf. Sci.* 90, 676 (1979).
1917. R. Feidenhansl, I. Stensgaard, *Surf. Sci.* 133, 453 (1983).

1918. U. Döbler, K. Baberschke, J. Haase, A. Puschmann, *Phys. Rev. Lett.* **52**, 1437 (1984).
1919. C. B. Duke, A. Paton, A. Kahn, K. Li, *Bull. Am. Phys. Soc.* **30**, 313 (1985).
1920. C. B. Duke, C. Mailhot, A. Paton, K. Li, C. Bonapace, A. Kahn, *Surf. Sci.* **163**, 391 (1985).
1921. J. Stöhr, D. A. Outka, R. J. Madix, and U. Dobler, *Phys. Rev. Lett.*, **54**, 1256 (1985).
1922. D. A. Outka, R. J. Madix, and J. Stöhr, *Surf. Sci.* **164**, 235 (1985).
1923. G. Casalone, M. G. Cattania, M. Simonetta, *Surf. Sci.* **103**, L121 (1981).
1924. Z. P. Hu, D. F. Ogletree, M. A. Van Hove, and G. A. Somorjai, *Surf. Sci.* **180**, 433 (1987).
1925. H. Kobayashi, H. Teramae, T. Yamabe, M. Yamaguchi, *Surf. Sci.* **141**, 580 (1984).
1926. B. A. Hutchins, T. N. Rhodin, J. E. Demuth, *Surf. Sci.* **54**, 419 (1976).

*LAWRENCE BERKELEY LABORATORY
TECHNICAL INFORMATION DEPARTMENT
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720*