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We have studied the clean (100) surfaces of both platinum and gold single crystals. The following surface structures, ordered and disordered, were found.

Table 1

Surface structures on the (100) substrates	Approximate temperature range (°C)
Au (5 × 1)	200-400
Au (6 × 6) ring	350-550 > 550
Pt (2 × 1)	300-500
Pt (5 × 1) ring	350-500 > 600

Thus, we find the same surface structures to exist on the (100) gold substrate as reported by Gjostein et al. We believe that these surface structures are the property of the clean metal surfaces and are not due to oxygen impurity.

The experimental observations which primarily indicate that the surface structures are the property of the clean substrate are:

(1) There is a good correlation between the types of surface structure which form on the different metal substrates, gold and platinum.

(2) The surface structures are present only in well-defined tem-

perature ranges. The type of surface structure varies on the same substrate as a function of temperature. They are ordered or disordered and show a broad spectrum of physical properties.

(3) The surface structures are reproducible on all of the samples which were studied. They are unaffected by heat treatment in hydrogen or oxygen atmospheres[1]. [It should be noted that oxygen structures can easily be removed from the Ni(110) substrate by heating in hydrogen at 200°C[2].] The Pt(100)-(5×1) surface structure coexists with the rotated oxygen structure[3]) which forms when the sample is heated in oxygen (2×10^{-6} Torr) at 440°C.

(4) The formation of these surface structures is independent of (a) the conditions of ion bombardment (type of ion, etc.); (b) sample thickness; (c) crystal holder material (platinum, gold, and tantalum).

(5) Heat treatments in ultra high vacuum, in oxidizing and reducing ambients, have not produced any new volatile species which could be detected by the mass spectrometer.

These properties of the observed surface structures which show complete reproducibility from sample to sample and in different laboratories, make it unlikely that these structures are due to uncontrolled impurities.

The properties of the surface structures are described in detail elsewhere[4,5]). In brief, the properties of the ordered surface structures may be explained by assuming that they are comprised of ordered arrays of vacancies in the substrate plane. The ordered surface structures form during annealing after ion bombardment. Ion bombardment causes a large fraction of surface atoms to occupy nonequilibrium surface sites. When the substrate temperature is increased sufficiently,

these atoms can diffuse to surface positions which are energetically more favorable. These appear to be domains of vacancy structures in which long range order can be established.

It is likely that one of the most stable arrangements of surface atoms is that in the clean substrate, i.e., the absence of any surface structure. It is significant however, that there seems to be other arrangements of surface atoms which exhibit long range order in a given range of temperature. In order to determine whether these structures may be formed in a substrate which has equilibrium vacancy concentration, cleaved or vapor etched surfaces should be used.

The properties of the disordered structures which give rise to the ring-like diffraction patterns have been described in detail[4,5]). These surface structures can be obtained without ion bombardment at high temperatures. The formation of these structures is irreversible, and they can only be removed by ion bombardment. Near the melting point, the ring patterns remain the only diffraction features of the presumably greatly disordered surfaces. The ratio of lattice parameters which can be assigned to the diffraction rings on platinum surfaces ($1:\sqrt{3}:2$) indicate that they can be due to domains of (111) surface structures. The disordered close-packed hexagonal surface structure seems to be the stable high temperature surface phase of platinum. The ratio of lattice parameters which can be assigned to the diffraction rings on the gold substrate ($1:\sqrt{2}$) seems to be different from that of platinum.

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