Title
FIELD ION MICROSCOPY OF TANTALUM-CARBON ALLOYS

Author
Rao, P.

Publication Date
1970-05-01

For 28th Annual Electron Microscopy Society of America Meeting, Houston, Texas, Oct. 5-9, 1970

UCRL-19630
Preprint

c. 2

FIELD ION MICROSCOPY OF TANTALUM-CARBON ALLOYS

P. Rao

May 1970

AEC Contract No. W-7405-eng-48

75

DISCLAIMER

FIELD ION MICROSCOPY OF TANTALUM-CARBON ALLOYS

P. Rao

Inorganic Materials Research Division, Lawrence Radiation Laboratory and Department of Materials Science and Engineering, University of California, Berkeley, California 94720

Transmission electron microscopy has proved the existence of interstitial order in the tantalum-carbon system(1,2) and the structure has been suggested to be tetragonal of composition $Ta_{64}C$. Detection of interstitial order using field ion microscopy is shown to be possible by observing the general morphology of the interstitial atoms appearing as bright spots at the tip surface. This is necessitated by the fact that photographic recording of stable images from interstitial solid solutions is difficult due to the inherent instability of interstitials present at and in a thin shell of undetermined thickness below the surface. However, interstitial ordering, if present, should be detectable by the appearance of regularly spaced rings of carbon atoms when both species (metal and interstitial) are continuously field evaporating. Under such conditions, photographic recording is possible (fig. 1c) and development of rings of bright spots denoting interstitial atoms can be seen as against a random distribution of bright spots indicating disorder.

Field ion micrographs from tantalum containing 1.53 atomic percent carbon (close to the ideal ordering composition 1.56 at. %) show the presence of carbon atoms in the first, fifth and ninth rings of atoms around the (111) poles in figures 1a and 1b, taken under stable conditions, and as rings of bright spots around the 110 poles (fig. 1c) when pictured under field evaporating conditions. In all cases, there is a preferential appearance of a ring of carbon atoms after every four rings of tantalum atoms.

In order to assist in the interpretation of the images, computed FIM images were obtained using the program of Ranganathan et al.,(3) assuming the $Ta_{64}C$ structure and c/a ratio of 1.08 with the carbon atoms occupying octahedral intensities. The tip radius was taken to be 100 times a for which a shell thickness $\underline{P}$ of 0.0736a has been predicted.(4) The results shown in fig. 2 are for $\underline{P}$ values of 0.0736a and 0.1104a.

Although there is not an obvious one-to-one correlation between observed and computed images, the latter predicts rings of carbon atoms such as is observed.

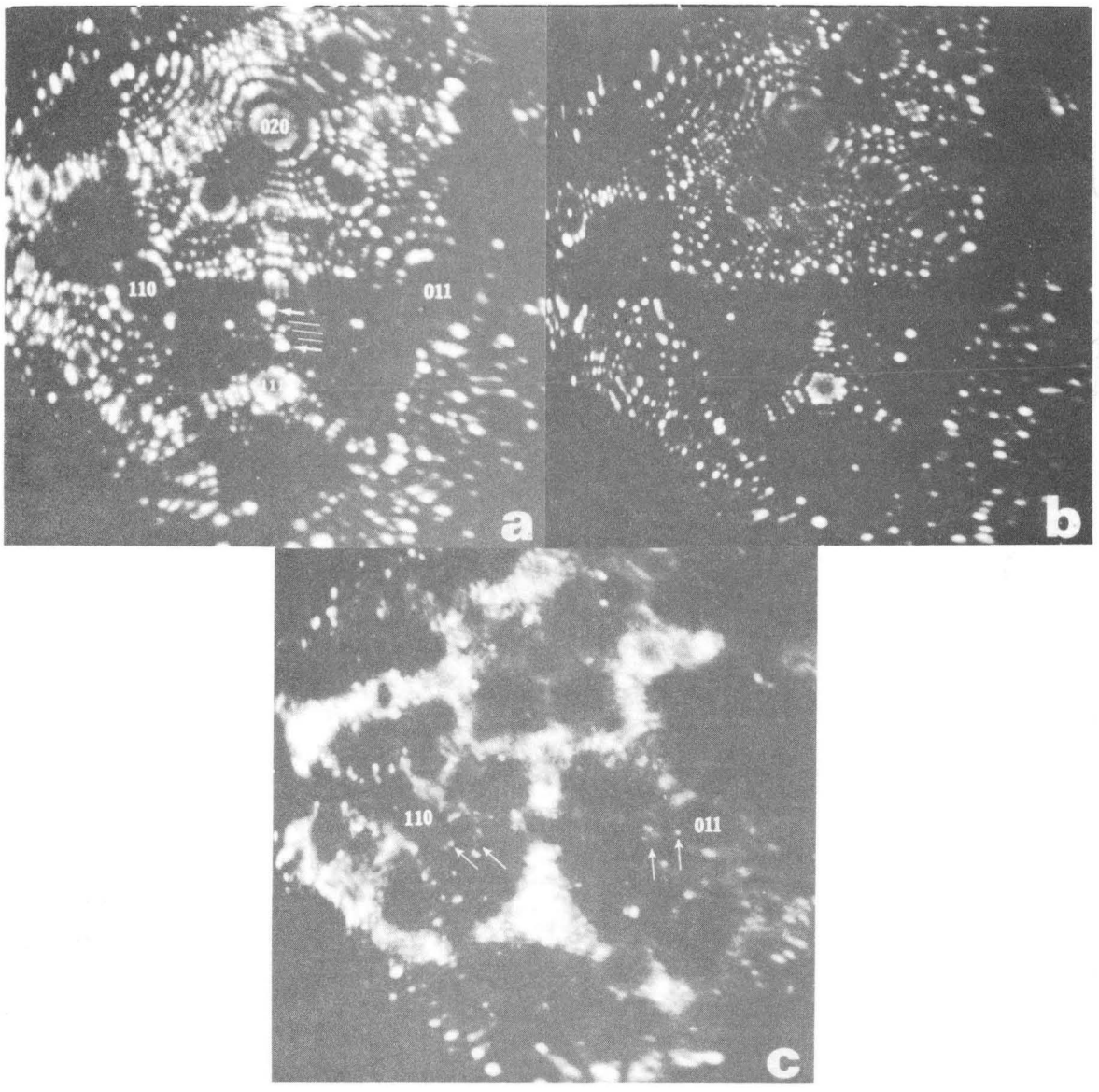
This work was performed under the auspices of the U.S. Atomic Energy Commission through IMRD of Lawrence Radiation Laboratory, Berkeley. The author gratefully acknowledges the direction and encouragement of Professor Gareth Thomas.

(1) Villagrana, R. E. and Thomas, G., Phys. Stat. Sol. 9, 499 (1965).
(2) Rao, P., Ph. D. Thesis, University of California, Berkeley (1969); University of California, Lawrence Radiation Lab. Report No. UCRL-19113.
(3) Ranganathan, S., Lyon, H. B., and Thomas, G., J. of Applied Phys. 38, 4957 (1967).
(4) Moore, A. J. W., Phil. Mag., 16, 793 (1967).

*The author is now with Ingersoll-Rand Research, Inc., Princeton, New Jersey.

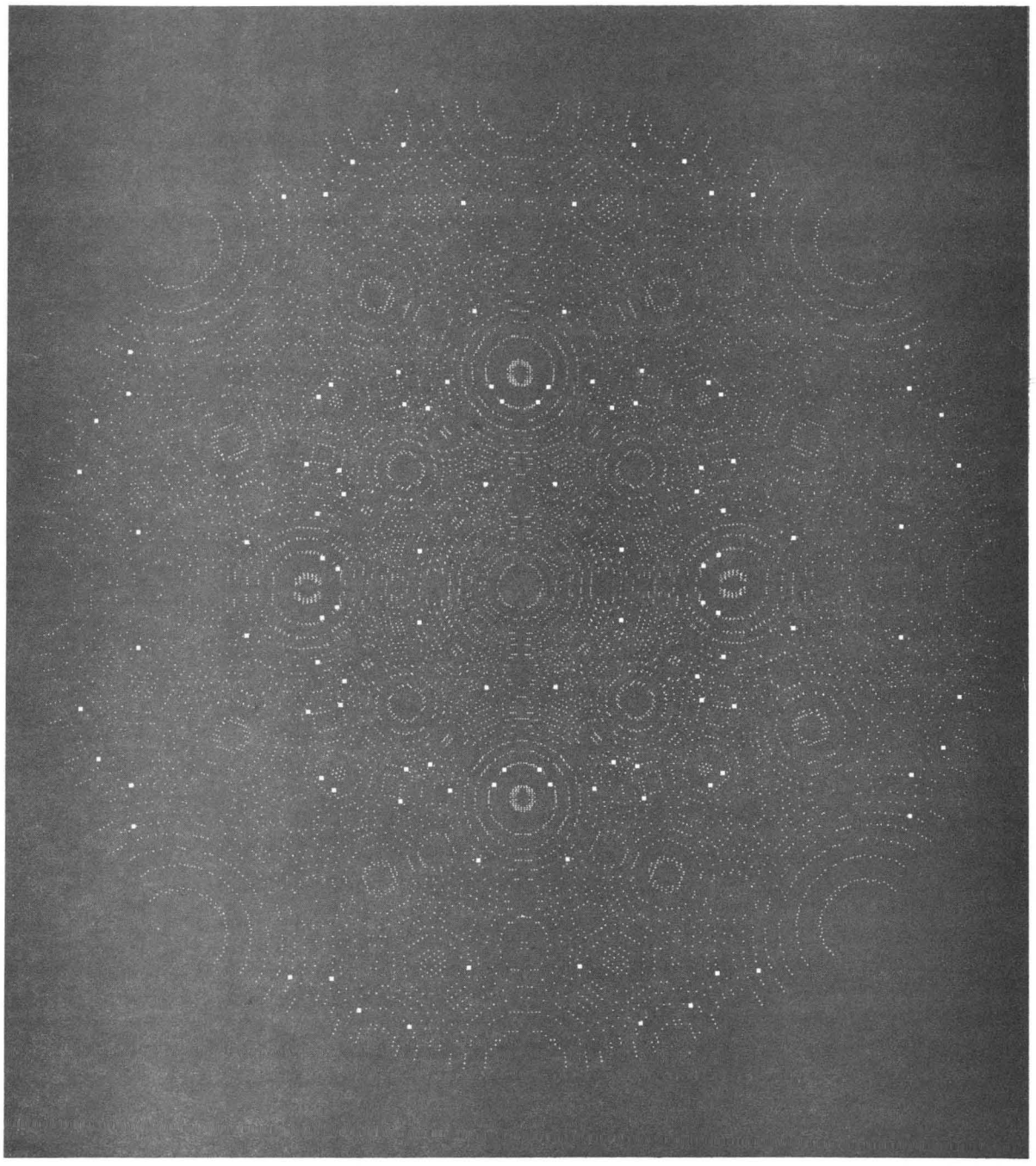
Fig. 1a, b, c. Field ion micrographs 1a - 1.53 at. %C at 20°K taken during field evaporation. Notice carbon atoms (bright spots) in rings at 111, 110.

Fig. 2. Computer generated field ion images of $Ta_{64}C$.
(a) 100 orientation P = 0.0736a
(b) 100 orientation P = 0.1104a



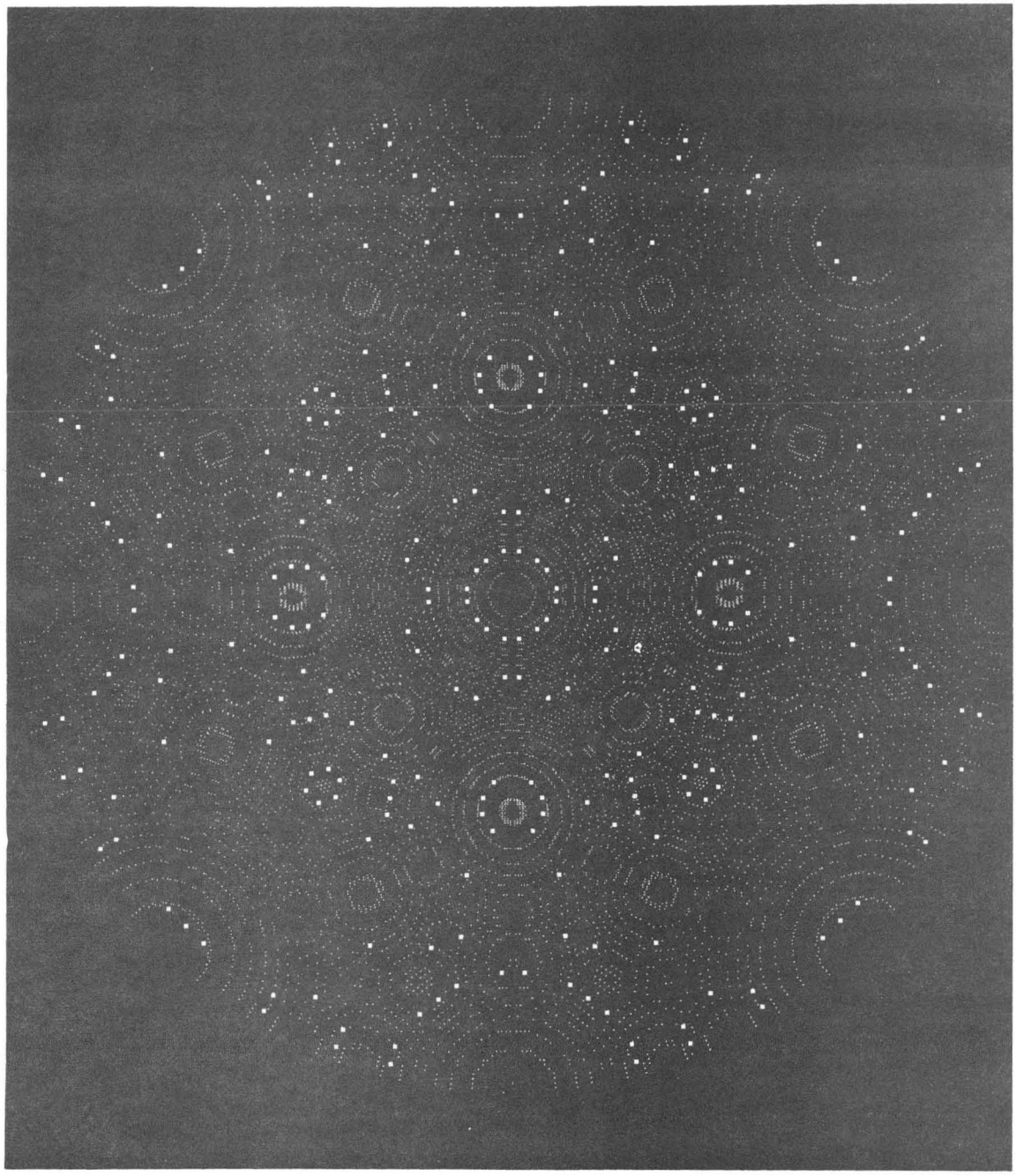
XBB 6911-7128

Fig. 1



XBB 6910-6790

Fig. 2a



XBB 6910-6794

Fig. 2b

TECHNICAL INFORMATION DIVISION
LAWRENCE RADIATION LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720