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FIELD ION MICROSCOPY OF TANTALUM-CARBON ALLOYS

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FIELD ION MICROSCOPY OF TANTALUM-CARBON ALLOYS

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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 interstices. The tip radius was taken to be 100 times a for which a shell thickness P of 0.0736a has been predicted.(4) The results shown in fig. 2 are for 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.

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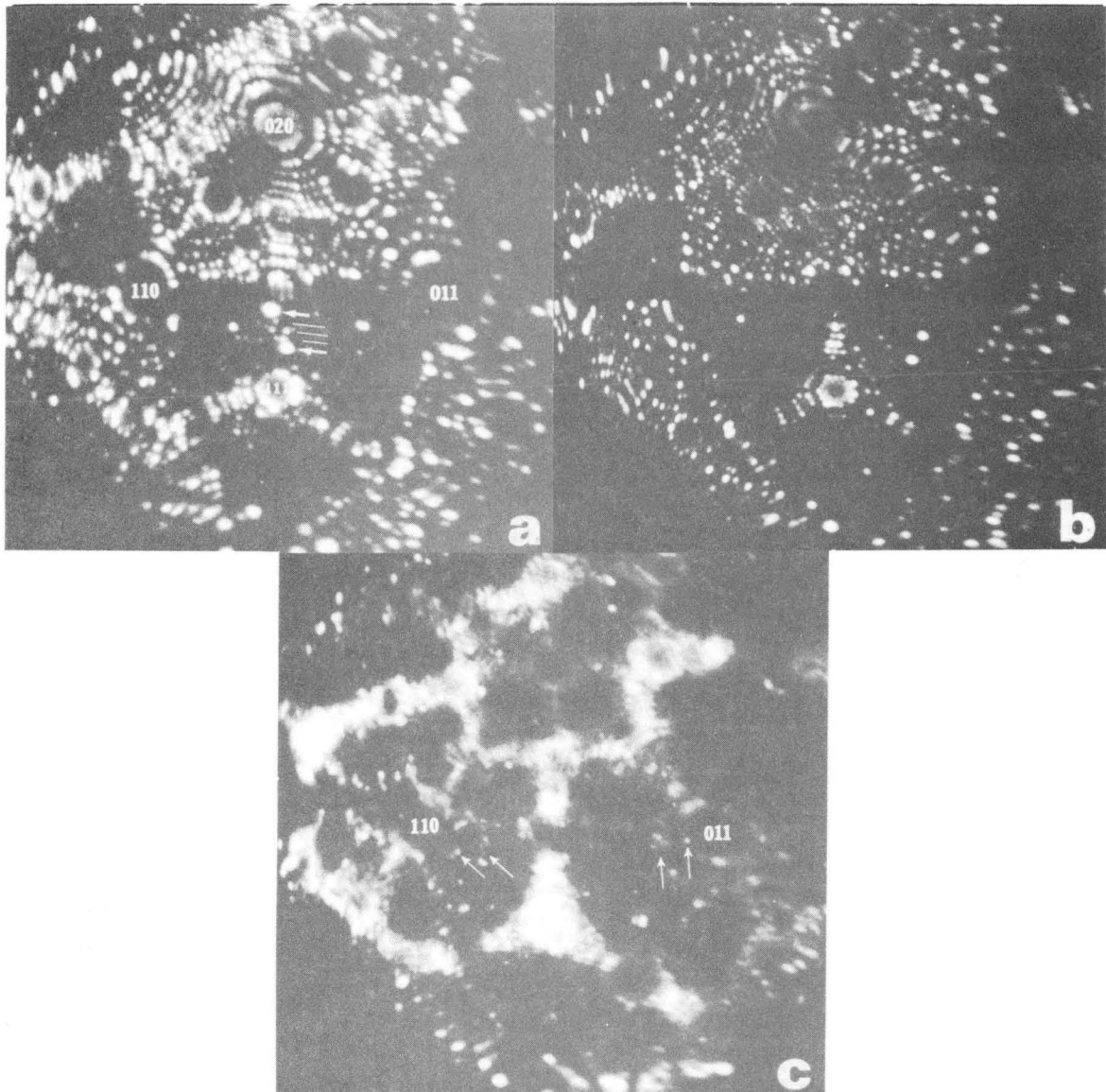
*The author is now with Ingersoll-Rand Research, Inc., Princeton, New Jersey.

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 Ta₆₄C.

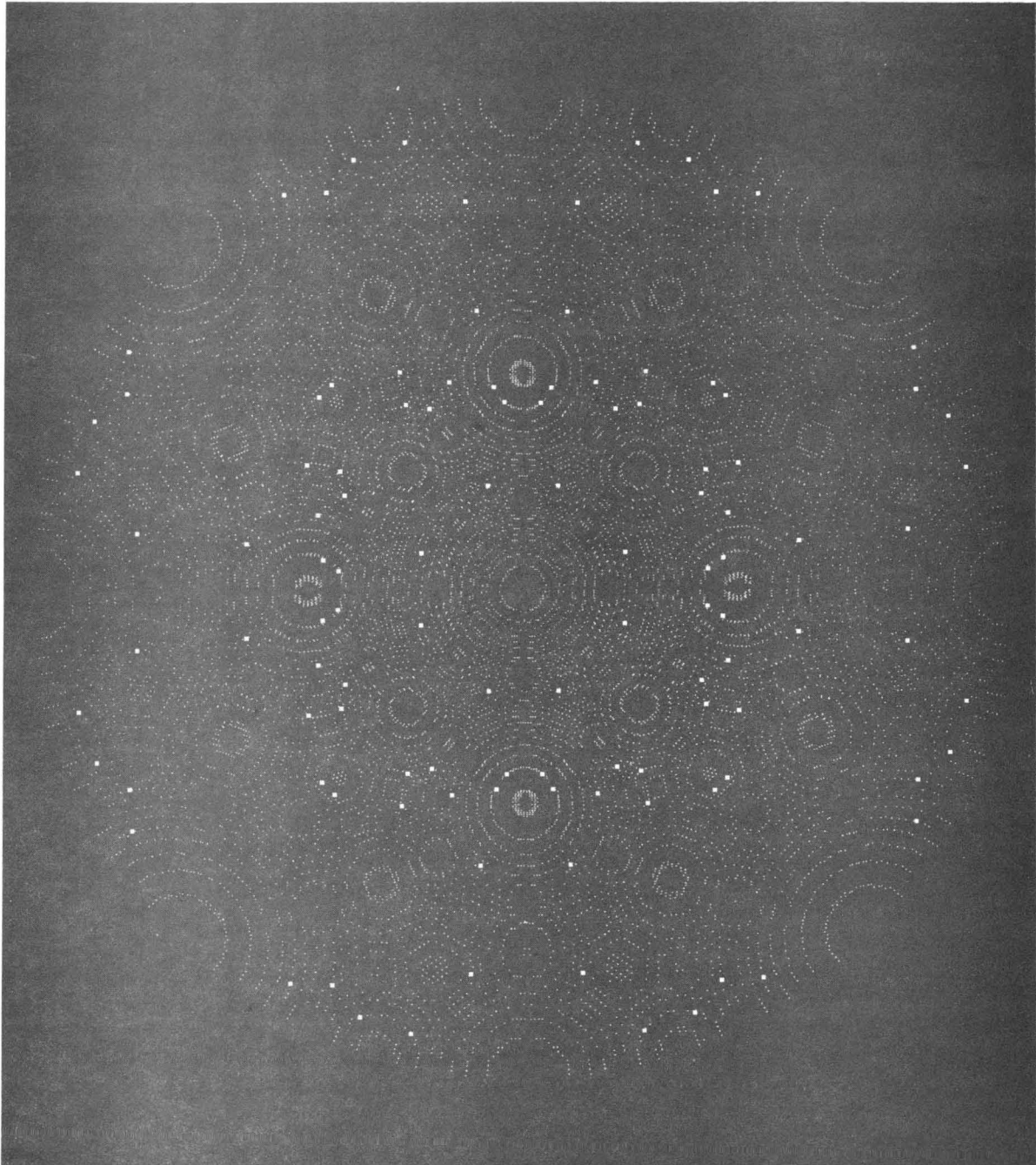
(a) 100 orientation P = 0.0736a

(b) 100 orientation P = 0.1104a



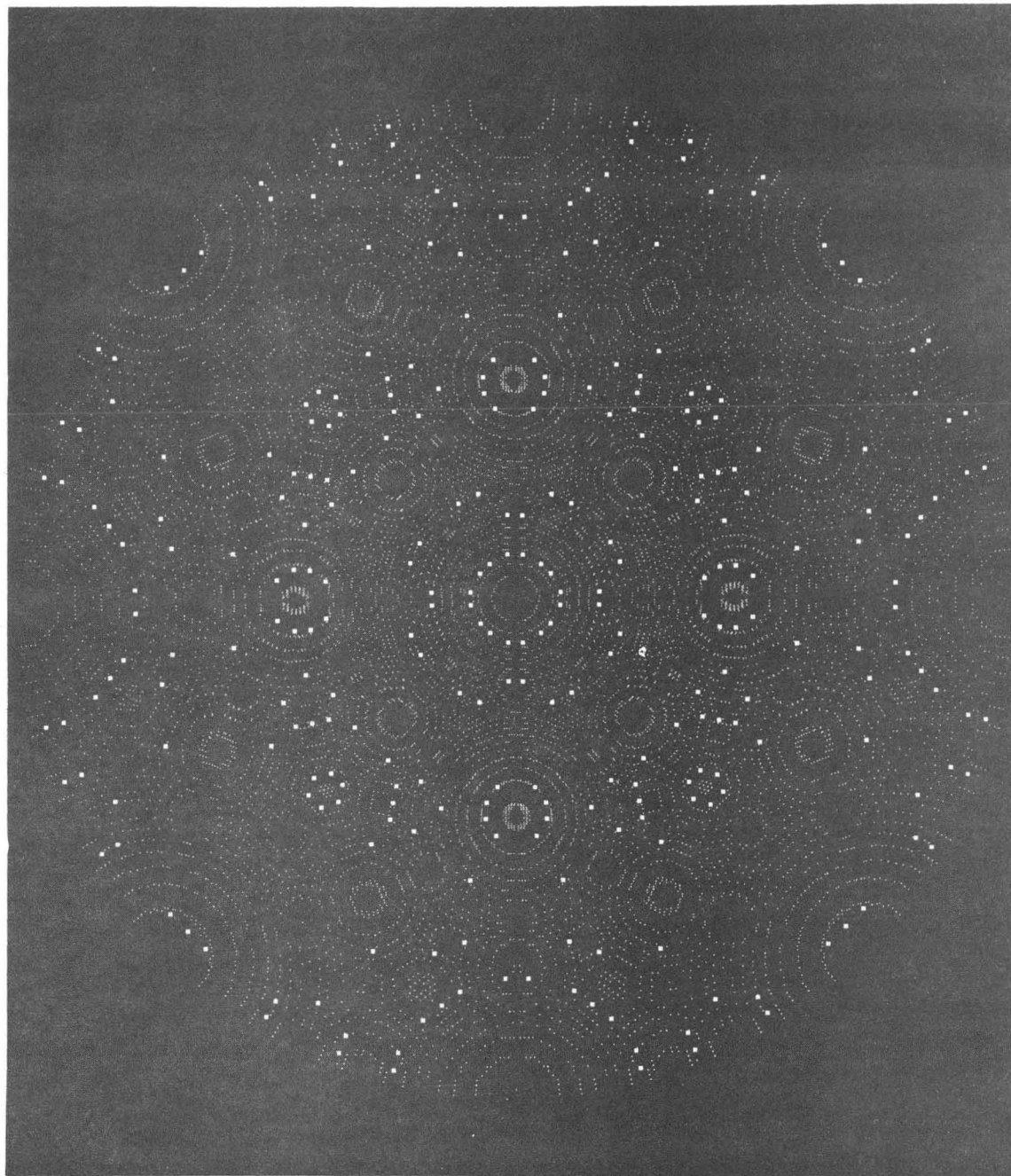
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Fig. 1



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Fig. 2a



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Fig. 2b

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