Title
PRELIMINARY OBSERVATIONS OF ELECTRON IRRADIATION DAMAGE IN SHORT-RANGE ORDERED Ni.Mo

Author
Sinclair, R.

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R. Sinclair, D. S. Gelles, and G. Thomas

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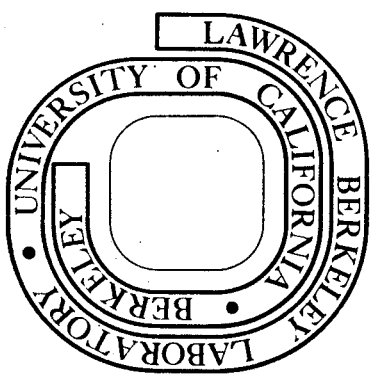

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R. Sinclair*, D. S. Gelles** and G. Thomas*

*Department of Materials Science and Engineering and MMRD, Lawrence Berkeley Laboratory, University of California, Berkeley, CA 94720. **Hanford Engineering Development Laboratory, P.O. Box 1970, Richland, WA 99352

Short-range order (SRO) in a solid solution is an inherently stable state. It is a highly localised phenomenon, with atomic correlations rarely extending more than a few unit cells and which is difficult to study and interpret by conventional methods. It has been invoked as one of the possible causes of low swelling rates during irradiation of specific alloys (1). This idea is currently gaining some foundation especially as swelling has been found to be low in Cu 15%Al (2) and Ni_4Mo (3), both of which are well-known SRO alloys (4,5).

The present experiments are aimed at evaluating the behaviour of SRO Ni_4Mo (produced by quenching from above the critical ordering temperature) in an irradiation environment. For this purpose, thin foils, prepared by electropolishing 3mm. discs in dilute H_2SO_4 at room temperature, were examined in a JEOL high voltage electron microscope operating at 1MeV (i.e. above the threshold displacement energy for both Ni and Mo). The temperature of the irradiated area was estimated to be 100°C, from the known temperature rise caused by the focussed electron beam in this microscope (6). The variation of selected area electron diffraction patterns was recorded during irradiation and dark field micrographs were taken in and near to the irradiated area.

SRO in Ni_4Mo is manifested by weak diffuse scattering at $\{1\frac{1}{2}0\}$ positions in diffraction patterns. A [112] zone illustrates this feature. Little variation was found in the intensity of the diffuse reflections upon irradiation of the sample in this orientation, up to a dose of five displacements per atom (fig. 1). Any change occurred in the direction of increased $\{1\frac{1}{2}0\}$ intensity. Thus SRO is indicated to be stable by the diffraction patterns. It seems significant that SRO was not destroyed by irradiation (disappearance of $\{1\frac{1}{2}0\}$ spots) nor that long-range ordering was induced (as would be revealed by the appearance of long-range order reflections at $\{\frac{4}{5}\ \frac{2}{5}0\}$ positions).

Dark field micrographs taken using $\{1\frac{1}{2}0\}$ reflections are shown in fig. 2. In the unirradiated area (fig. 2a) the tiny (~10Å) microdomains, which characterise SRO in this material and which are extremely difficult to image (7), are unresolved. In the irradiated area the image resolved ordered domains (fig. 2b), indicating that the nature of SRO has indeed changed during irradiation, with the production of larger microdomains.

This experiment shows that SRO in Ni_4Mo is not destroyed by electron irradiation up to 5 d.p.a., but indicates that domain coarsening may occur. Clearly this result is of considerable interest in assessing the effect of radiation damage on the fine structure of alloys, and vice-versa, and that further characterisation of this reaction is desirable.

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1. Johnston, W. G., A.S.M. Materials Science Seminar, Cincinnati, Nov. 1975.
2. Adda, Y., Radiation Induced Voids in Metals, edited by J.W. Corbett and L.C. Ianello, p. 31, publ. by USAEC Techn. Inf. Serv. (1972).
3. Kenik, E. A., and R. W. Carpenter, (Oak Ridge Nat'l Lab.) private communication (1976).

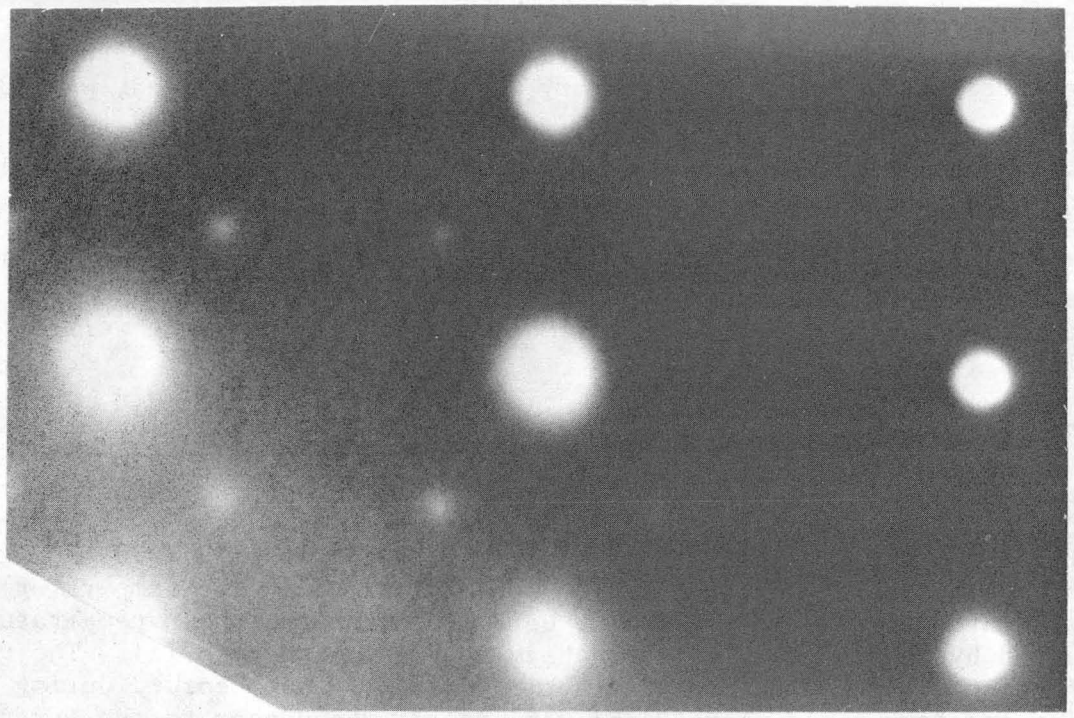


Fig. 1 (a)

[112] electron diffraction patterns of SRO Ni_4Mo after 0.25 d.p.a.

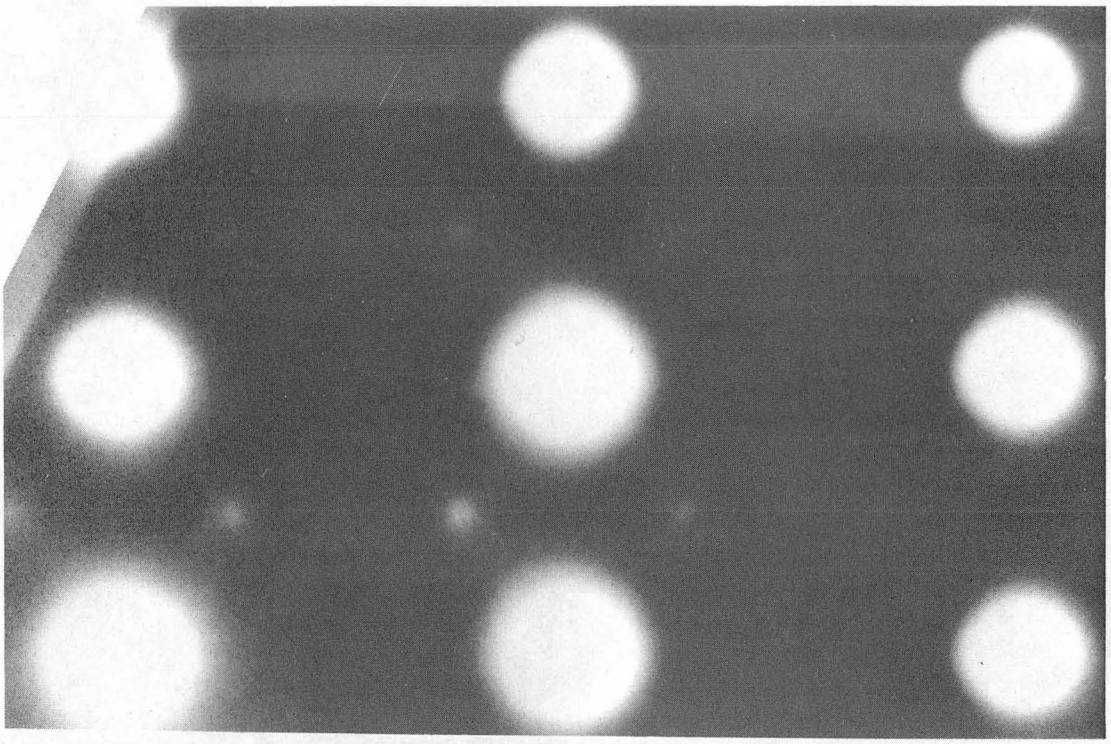
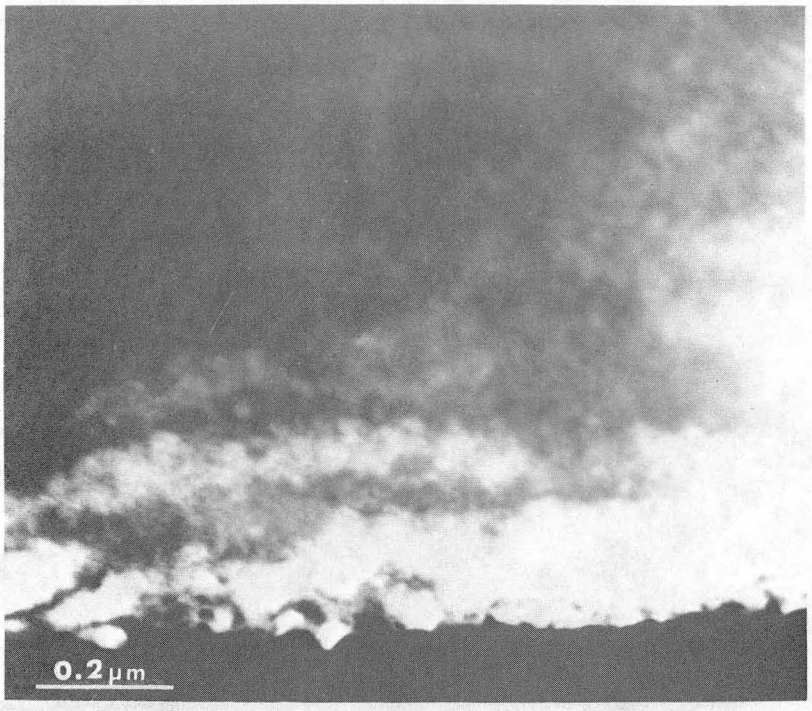
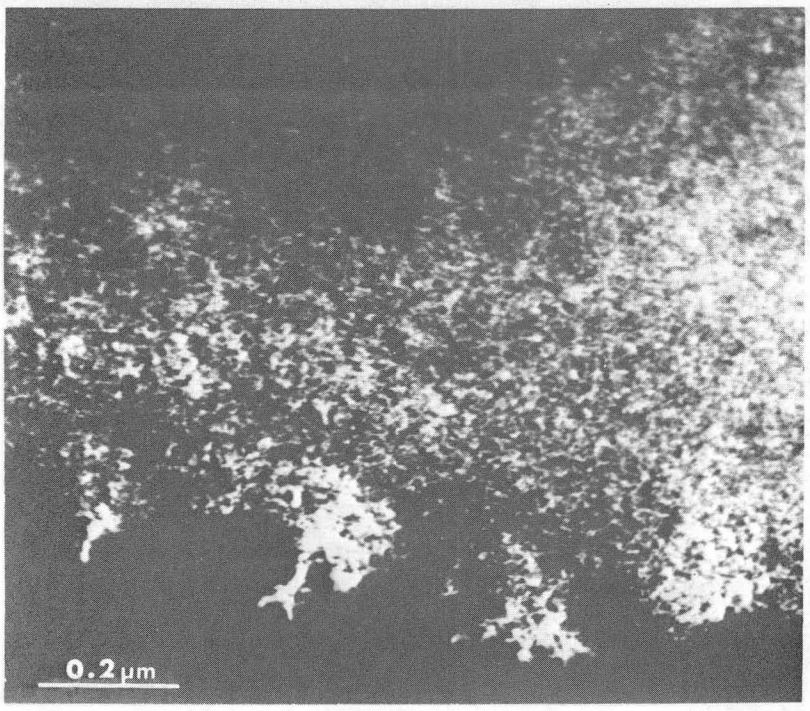


Fig. 1 (b) XBB 763-2691

[112] electron diffraction patterns of SRO Ni_4Mo after 2.5 d.p.a. by 1MeV electron irradiation.



(a)



(b)

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Fig. 2

{1½0} dark-field micrographs of Ni_4Mo (a) unirradiated, (b) irradiated to a 5 d.p.a.

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