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SWELLING IN REFRACTORY METALS DURING
HIGH TEMPERATURE ION BOMBARDMENT

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High temperature neutron irradiation and high energy heavy ion bombardment have been shown to be equally effective in producing voids in refractory metals.⁽¹⁾ The heavy ion technique has the added advantages in that it can produce equivalent displaced atom densities in 1/10,000 of the time required by neutron irradiation^(2,3) and induces no radioactivity in the samples. These attributes render this damage simulation technique extremely valuable for screening studies of candidate materials for future LMFBR's or Fusion Reactors. The purpose of this note is to present recent results of a survey on the void-induced swelling in selected refractory metals and alloys after irradiation in the 650-1000 °C temperature range. The damage level was held constant at approximately 5 dpa (displacements per atom).

No voids were found in Mo, TZM (a titanium-zirconium modified molybdenum alloy) and Nb after the 650 °C irradiation. Voids were found in these metals after 800, 900, and 1000 °C. Figure 1 shows typical microstructures after the 900 °C bombardment. The void sizes are 75 Å, 80 Å, and 120 Å for the Mo, TZM and Nb, respectively. These voids result in volume changes of 1%, 0.43%, and 0.83% for Mo, TZM and Nb, respectively. The average void size increased and number density decreased, as expected, with increasing irradiation temperature.

The morphology of the voids in the Mo samples is difficult to determine because of their small size. However, the voids in Nb were large enough after the 1000 °C irradiation to determine that they are {100} cubes with slight amounts of {110} truncation.

Voids were also found in vanadium after 700 and 800 °C, but not after 900 °C bombardment. Figure 2 shows a typical microstructure after 7.5 MeV Ta ion bombardment at 800 °C. Preliminary results indicate that the voids in vanadium are also {100} cubes.

REFERENCES

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FIGURES

Figure 1 Production of voids in refractory metals during 900 °C bombardment with 5 MeV nickel ions. Damage level ~5 dpa.

Figure 2 Voids in vanadium after 800 °C bombardment with 7.5 MeV tantalum ions.

VOIDS PRODUCED BY 900 °C HEAVY ION BOMBARDMENT

Mo

TZM

Nb

DAMAGE ~ 5 dpa

0.5 μ

VOIDS IN V AFTER 800⁰C BOMBARDMENT
WITH 7.5 MeV Ta IONS