§30. Large Scale of Computer Simulation on the Effects of Overlapping of Displacement Damage in Neutron-irradiated Fusion Reactor Materials

Shimomura, Y., Mukouda, I., Sugio, K. (Hiroshima Univ.)

When a displacement damage cascade forms in fusion reactor materials which are irradiated by fusion neutrons, a core of the cascade expands adiabatically and a shock wave is generated. When a shock wave collides with damage cascades which are formed previously, it may cause the structural relaxation of damage cascades formed previously. In the present work, the first damage cascade in silver due to a primary knock-on atoms of 5 keV is generated. Subsequently the second cascade damage due to 5 keV is generated as the manner of part of cascade core is overlapped. It is found that a change of damage structure of the first cascade by overlapping with the second cascade is small. A shock wave runs much faster than the elastic sound wave. A structural relaxation proceeds by the speed of sound wave so that a shock wave can not relax a damage formed previously. When damage cascades are generated to a high density as 1018 damage_cascade/cm^3, another type of damage evolution occurs[1]. In this case, small point defect clusters of interstitial and vacancy form very closely. In fcc metals, a small interstitial cluster has a structure of parallel <110> crowdions. A bundle of <110> crowdions move with the fundamental step of one dimensional movement of <110> crowdion[2]. The activation energy of movement of a bundle of <110> crowdion is very small so that the movement of <110> crowdion affects very sensitively on the small strain due to surrounding defects. Interstitial clusters tend to form its grouping[2,3]. At high temperature such as 200°C in Cu, the group evolves to dislocation structure of jogging shape[1]. At high temperature such as 300°C in Cu, dislocation evolves to a straight line which does not have a jogging shape[1]. After an interstitial cluster is moved to their grouping, a large number of vacancy cluster are left inside a crystal grain. It is shown by the computer simulation that a structure of vacancy cluster relaxes to a string-like shape at small size such as below 20 vacancy. In this structure each vacancy is connected by the nearest neighbor position and can move as a cluster as shown in Fig. 1 (a) and (b). When small movable vacancy clusters coalesce with each other, a cluster grows to a relaxed structure such as stacking fault tetrahedron (sft). When two movable vacancy clusters whose size is relatively larger coalesce, a resultant cluster grows to a void. The formation of voids in irradiated fcc metals is due to an insufficient time of structural relaxation to the most stable structure of sft. It is concluded that voids can be nucleated from the clustering of only vacancies[1].

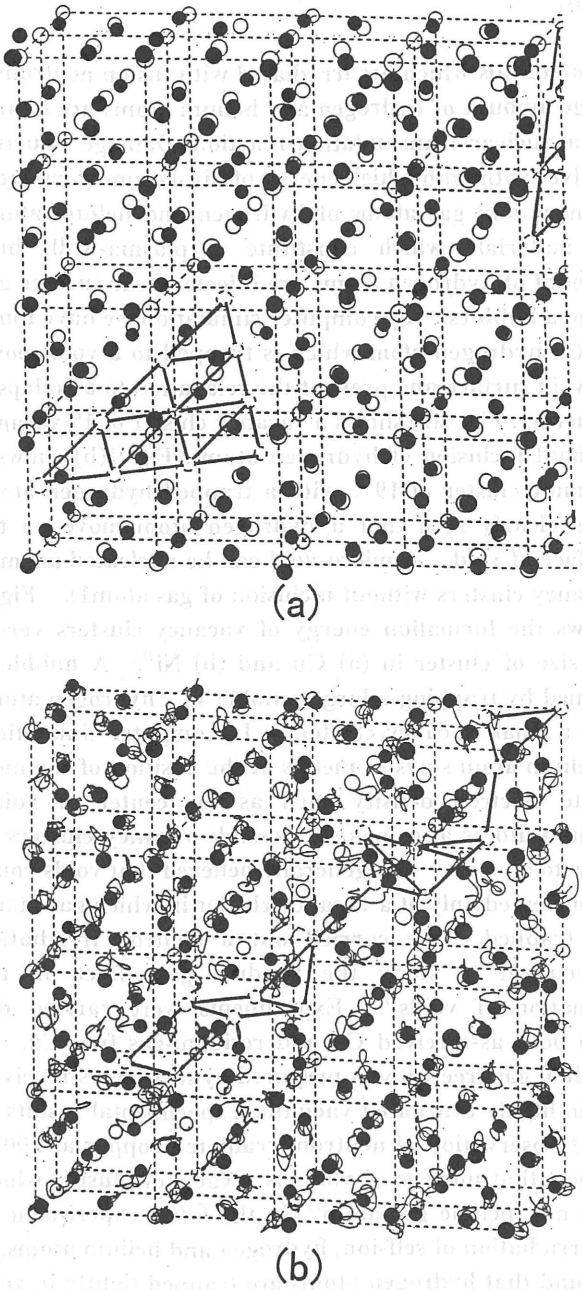

Fig. 1

Reference

1) **Shimomura, Y., Mukouda, I. and Sugio, K. : J. Nucl. Mater. 251(1997)61-71.**
2) **Zhao, P. and Shimomura, Y. : Jpn. J. Appl. Phys. 36(1997)7291-7295.**
3) **Sugio, K., Shimomura, Y. and de la Rubia, T. D. : J. Phys. Soc. Jpn. 67(1998)116-123.**