CASCADE IN METALS CREATED BY ION IRRADIATION

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The aim of this study is to investigate the processes of the formation of defect clusters within irradiated metals. The initial stage of the defects is considered to be the displacement cascade that consists of a vacancy rich region and surrounding interstitial atoms. Through diffusion like processes the cascades develop into defect clusters such as loops and voids. In order to develop materials that resist irradiation the knowledge of the whole processes of the cluster formation should be revealed. So, our plan has to cover the cascade stage of the defects, that needed a special apparatus which freeze the state during the course of the experiment.

To proceed the study we have developed a cryogenic system that keeps the sample temperature low throughout the experiments; namely, during the ion irradiation at JAERI tandem accelerator, transportation to KEK and measurements on the diffractometer of BL-27B.[1]

The experiments were carried out as follows. Single crystal Ni sample oriented [200] direction was mounted on the cryostat and irradiated by 110MeV iodine ions up to $7x10^{13}$ ions/cm^2 with the tandem accelerator. Being kept temperature below 20K with the liquid He the sample was transferred to BL-27B. The temperature was also kept around 20K during the measurement of diffuse scattering. Unfortunately, at some instance of the sample transfer the temperature rose accidentally up to 200K. Hence we consider the sample has been annealed at 200K. The diffuse scattering was defined by the difference of the signals of the irradiated region from that of a non-irradiated region.

Figure 1 shows an example of the diffuse scattering signals. These were taken by the theta-2theta scan along [200] direction. In the figure the vertical axis shows a particular value, i.e. the diffuse scattering is multiplied by q^4 , which is good to see the 'structure' of the clusters. The signals in the positive/negative q region relate to interstitial/vacancy clusters, respectively. Large size of the cluster corresponds to small q value of the peak position of the curve. Two cases of the annealing temperature, 200K and 300K, are shown in this figure.

The profile change between 200K and 300K cases can be explained qualitatively as follows. The motion of the clusters should take place at 300K annealing as from 200K state. As the result of the motion the size of the clusters seems to increase, due to agglomeration, with the increase of the temperature. The decrease of intensity of 300K case, however, indicates that some of clusters disappeared owing to both recombination with vacancies and loss at the boundary. The reason why the size of clusters as well as the number of interstitial clusters are larger than that of vacancies is unknown. Detailed analyses of these results are under study.

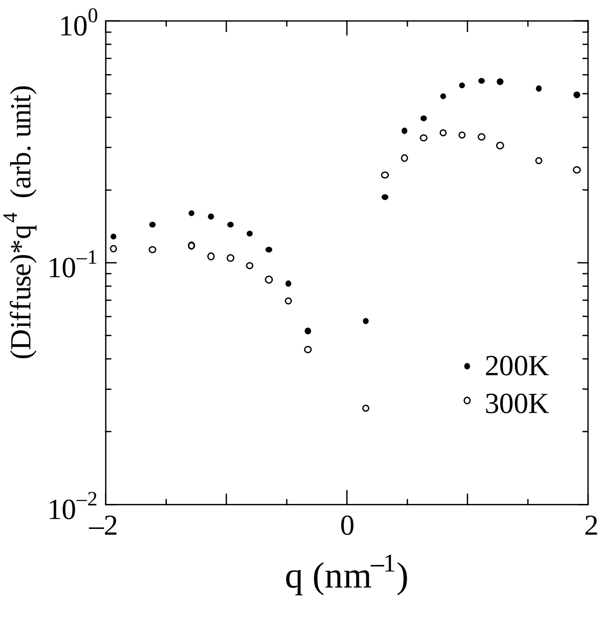

Fig.1 q-dependence of a diffuse scattering modified by q^4. Two cases of annealing temperature, 200K and 300K, are shown. The data were taken by the theta-2theta scan along [200] direction.

Reference
[1] H.Maeta et al., PF Activ Rep. 1999, B 75(2000).

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