In-situ transmission electron microscopy study of evolution of dislocation loops in irradiated reactor pressure vessel model alloys

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In order to investigate the mechanism of dislocation loop evolution under irradiation, particularly loop growth, Fe-based alloy is selected and in-situ irradiation in TEM following bulk irradiation is performed in this work. The growth kinetics of loops and the effect of one-dimensional migration of loops are investigated.

Keywords: dislocation loops, reactor pressure vessel model alloy, in-situ transmission electron microscopy

1. Introduction

Dislocation loop is a principal feature of radiation damage in nuclear structural materials such as reactor pressure vessel steel. The evolution of loops under irradiation has been predicted by modelling studies. However comparable experimental data are desired to validate and guide the modelling. Also, the understanding of loop behaviour under irradiation will provide the basis for clarifying the interaction between solute atoms and radiation defects. The objective of this work is to investigate the mechanism of loop evolution under irradiation, particularly loop growth which can be a dominant phenomenon at high dose region. For this purpose, first, bulk of Fe-based alloy is irradiated to produce well visible loops, and then subsequent in-situ irradiation with accelerator-TEM linked facility is performed to observe the evolution of loops. The growth kinetics of loops is investigated, and the effect of one-dimensional migration of loops is analysed.

2. Experimental

Bulk of Fe-based alloy, Fe-0.6wt.%Ni is irradiated with 2.8 MeV Fe^{2+} ions to 1 dpa at 400 ^{o}C at the High Fluence Irradiation Facility, The University of Tokyo (HIT). Then foil specimen for subsequent in-situ irradiation is prepared using FIB. This is followed by flash polishing to fully remove FIB-induced damage. The in-situ irradiation is performed with 1 MeV Fe^{2+} ions at 400 ^{o}C with TEM observation.

3. Results

Fig. 1 shows the growth kinetics of large loops under in-situ irradiation in Fe-0.6Ni. Two types of growth behavior can be observed. One typical case is the growth with constant speed, and the other is the abrupt growth with rapid size increase. The constant speed growth can be estimated based on rate theory, assuming loop growth by absorbing freely-migrating defects [1]. Detailed analysis of TEM images indicates that the abrupt growth should be contributed by one-dimensional migration of loops. The one-dimensional migration is then analysed.

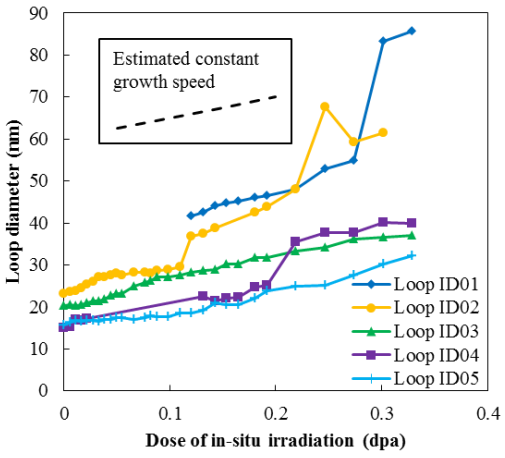

Fig. 1. Growth kinetics of loops under in-situ irradiation

References

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