Nature of defect clusters produced in ferritic model alloy at elevated temperatures

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To develop new method to determine the nature of defect clusters, especially those smaller than 10 nm, bulk irradiation is combined with in situ irradiation in transmission electron microscope. In this work, reactor pressure vessel model alloy Fe-Mn is used. The behaviour of defect clusters under in situ irradiation is analysed.

Keywords: reactor pressure vessel, dislocation loops, model alloy, combined irradiation, in situ transmission electron microscope

1. Introduction

Dislocation loop is a principal feature of radiation damage, pertinent to embrittlement of nuclear reactor pressure vessel (RPV) steel. Whether such loops consist of agglomerates of vacancies or of interstitials is one of the most fundamental questions, and is a basis to understand the interaction between solute atoms and radiation defects. The inside-outside technique can provide a recipe for nature determination for loops larger than 10-20 nm. However, the average size of loops produced in RPV materials is typically smaller than 10 nm [1]. The objective of this work is to develop new method to determine the nature of small defect clusters, via combining bulk irradiation and in situ irradiation in transmission electron microscope (TEM). The behaviour of defect clusters under in situ irradiation is focused on.

2. Methodology

Bulk irradiation and in situ irradiation are performed with a tandem accelerator at the High Fluence Irradiation Facility, The University of Tokyo (HIT). Bulk of model alloy Fe-1.4wt.%Mn is irradiated to 0.2 dpa at 400 ^{o}C to produce loops, and then foil specimen fabricated from the irradiated sample is subjected to in situ irradiation in TEM at 300 ^{o}C. In this work, thin foil is used so that freely migrating interstitials will be absorbed by surface sink under in situ irradiation.

3. Results

Fig. 1 shows TEM images taken at the start of in situ irradiation and at 60 min (~0.2 dpa) of in situ irradiation. Pre-existing loops at the start of in situ irradiation have diameters ranging from 4 to 12 nm with an average of 8 nm. These loops shrink and disappear under in situ irradiation. Meanwhile, new loops form. The behaviour of loops is analysed and the loop nature is discussed.

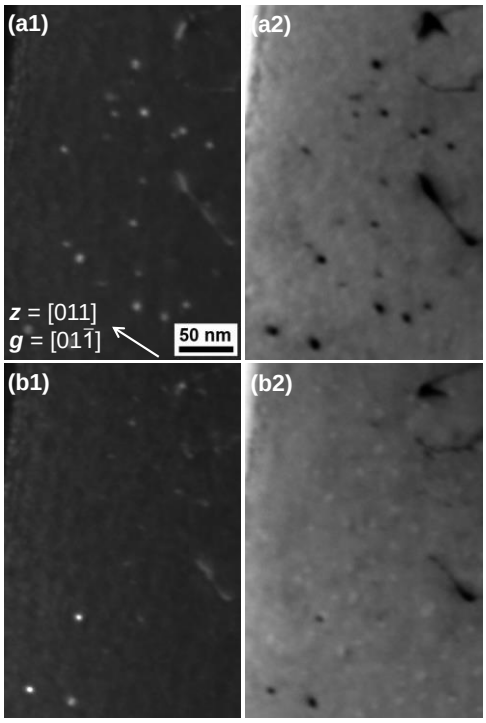

Fig. 1. TEM images of the same area: (a) at the start of in situ irradiation, and (b) at 60 min of in situ irradiation.

References

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