

Effects on Mn addition on dislocation loop formation in ferritic alloys

*Ranran Li^{1,2}, Hideo Watanabe¹ and Farong Wan²

¹Kyushu Univ., ²Univ. of Sci. and Technol. Beijing, China

Abstract: In this study, small defects formed in Fe-1.4wt.%Mn alloy developed into large dislocation loops during the annealing at the high temperatures. The nature of dislocation loops was investigated at the different annealing temperature by HVEM and TEM. The vacancy-type dislocation loops in Fe-1.4wt.%Mn alloy were observed to form at the temperature of 450°C and above.

Keywords: Fe-1.4wt.%Mn, hydrogen, vacancy-type loops

1. Introduction

Reduced activation ferritic/martensitic steels have been considered as one of the most promising candidate structural materials for future fusion reactors^[1]. During irradiation, different defects such as dislocation loops, solute clusters, and microvoids can form in these steels, which have contributed to swelling, low-temperature hardening, etc^[2,3]. However, in most studies, dislocation loops as one of the most common microstructures of irradiation in materials were focused on the interstitial-type loops in iron and ferritic alloys, and few studies given attention to the vacancy-type loops^[4,5].

2. Experiment

In this work, two methods were used to discuss the formation temperature of the vacancy-type loops in Fe-Mn alloy.

(1) Fe-1.4wt.%Mn model alloy was pre-implanted with hydrogen ions at room temperature. Then, the nature of dislocation loops formed during the electron irradiation at the corresponding annealing temperature was investigated by the high voltage electron microscope (HVEM).

(2) Pure Fe, Fe-1.4wt.%Ni and Fe-1.4wt.%Mn model alloys were pre-implanted with hydrogen ions at room temperature. Then, the samples were annealed for 20 minutes at different temperatures range up to 550°C. The dependence of the formation temperature of the vacancy-type loops was examined by comparing the change of size and density of dislocation loops at different annealing temperature.

3. Results and discussion

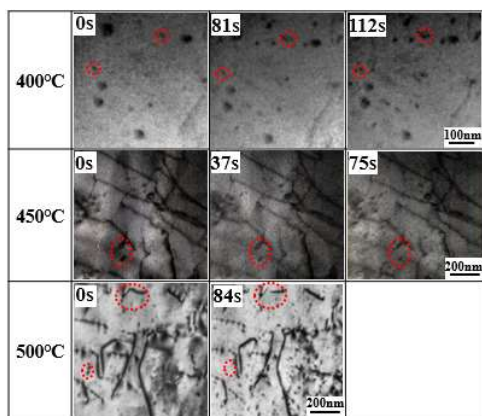


Fig.1 The evolution of loops under electron irradiation at different temperature in Fe-1.4wt.%Mn by HVEM

The figure 1 shows the microstructure evolution of Fe-1.4wt.%Mn alloy during electron irradiation. All of the loops were observed to grow at 400°C during the electron irradiation. Shrinking processes of small amount of dislocation loops under the electron irradiation were observed when annealed at 450°C and 500°C. It can be guessed that the vacancy-type dislocation loops in Fe-1.4wt%Mn alloy had formed at the annealing temperature of 450°C and above.

Comparing with the previous study, the formation temperature of vacancy-type loops will be decreased by adding manganese to bcc iron.

References

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