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Study on Cu Precipitation Induced by Thermal Annealing in FeCu alloy by Using EXAFS Spectroscopy

Akihiro IWASE[1], Sinya KOSUGI[1], Shou NAKAGAWA[1], Yoshihiro OKAMOTO[2]
[1]Osaka Prefecture University, Sakai, Osaka 599-8531, Japan
[2]Japan Atomic energy Agency, Tokai, Ibaraki 319-1195, Japan

Introduction

One of the important factors which cause the embrittlement in pressure power vessel steel of nuclear power reactors is Cu precipitation produced through the irradiation enhanced segregation mechanism. In our previous papers[1-3], we have reported that Cu precipitates induced by energetic ion and electron irradiations increase the micro Vickers hardness of FeCu model alloys. EXAFS spectroscopy is a good tool for the study on Cu precipitation in Fe-based alloys because we can observe atomic arrangements only around Cu atoms if we use the X-ray with energies near Cu K absorption edge. In this report, we show the EXAFS spectra at Cu K edge as well as the result of Vickers hardness measurement for thermally annealed FeCu alloys.

Experimental Procedure

Specimens were prepared from Fe-1.2wt.%Cu alloys. The specimens were annealed at 500C for 6, 12, 24 and 48 hours. After the thermal annealing, the micro Vickers hardness was measured as a function of annealing time. EXAFS spectra at Cu K absorption edge were collected using the 27B beamline at the Photon Factory of High Energy Accelerator Research Organization (KEK-PF). The spectra were obtained using a 7 element germanium detector in the fluorescence mode. For comparison, EXAFS spectra for pure Fe and Cu foils were also measured in the transmission mode.

Results and Discussion

Figure 1 shows the dependence of hardness change on annealing time for Fe-1.2wt.%Cu alloys. The hardness shows the maximum value around 10 hours and then decreases.

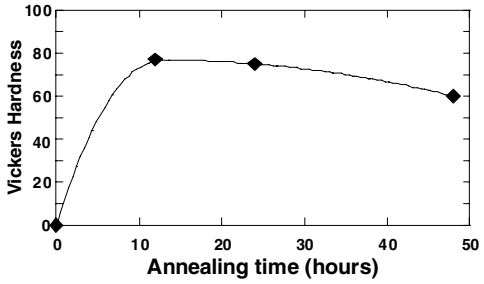

Fig. 1 Vickers hardness for Fe-1.2wt.%Cu as a function of annealing time.

Figure 2 shows the k^3-weighted Foulier transforms corresponding to the EXAFS spectra for thermally annealed Fe-1.2wt.%Cu specimens. The spectra for pure Fe and Cu foils are also shown. The shape of EXAFS spectrum before thermal annealing is similar to that for pure Fe. This result implies that Cu atoms occupy the regular atom sites for BCC structure. With increasing the annealing time, the shape of EXAFS spectra becomes similar to that for pure Cu. The present result suggests that the structure of Cu precipitates gradually change from BCC to FCC with increasing annealing time.

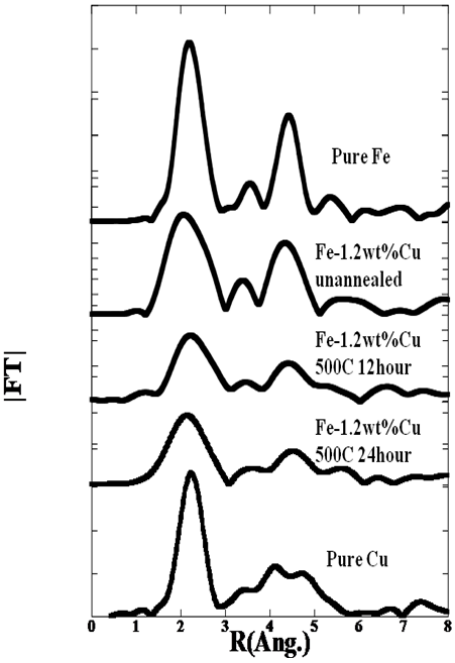

Fig.2 EXAFS-FT spectra for thermally annealed Fe-1.2wt.%Cu. For comparison, spectra for pure Fe and Cu are also shown.

References

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* iwase@mtr.osakafu-u.ac..jp