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Local structure analysis of nanocrystalline $Fe_{83.3}Si_4B_8P_4Cu_{0.7}$ alloy studies by XAFS

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1 Introduction

The FeSiBPCu nanocrystalline alloy has a feature of the high saturation magnetic flux density and a super-low core loss as a soft magnetism material. It is expected as a material of a transformer or a motor core in the future, and drastic reduction of the amount of discharge of carbon dioxide can be realized from the character of a super-low core loss. As a just preparation of the sample, the structure is amorphous like. A primary phase transition occurs at the 675K where the part of amorphous Fe crystallizes first and a secondary phase transition at 800K shows that the sample changes to crystalline completely. The intermediate state annealed between these temperatures shows high magnetic density and low core loss. The local structure is expected to be nanocrystalline state, however, detail mechanism for the formation of nanocrystalline is not clear. EXAFS is powerful tool for investigation of the local structure with element selectively. In this paper, *K*-edge XAFS analyses of Fe, Si, P, and Cu were performed for the sample prepared with various annealing conditions.

2 Experiment

The ribbon sample of $Fe_{83.3}Si_4B_8P_4Cu_{0.7}$ of produced by the arc melting in Ar and was solidified rapidly in the atmosphere using single-roller melt-spinning. They were annealed at 693K, 713K, 733K, 793K, and 823K for 60 min with a heating rate of 40K/min. The annealing time is 60 min and the speed of heating is 40K /min. The *K*-edge XAFS of Fe (BL12C, Trans), Si (BL11B, SSD), P (BL11B, SSD), and Cu (BL12C, 19SSD) were performed at Photon Factory, KEK, Japan.

3 Results and Discussion

The Fourier transform (FT) of the EXAFS of Fe *K*-edge is shown in Fig. 1. FT of the as-spun sample shows amorphous. By annealing at 693K the peak intensities increases compared with an as-spun sample and become close to bcc Fe structure. This indicates that the circumference of Fe crystallized by the annealing at 693K and it shows no more change with further annealing. Figure 2 shows FT for P *K*-edge. The peak intensities once decreases by annealing at 693K, and increases greatly by annealing at 793K. The results suggest that the local structure is distorted after the first annealing (693K) and crystallize higher annealing (793K) than Fe. Figure 3 shows FT for Cu *K*-edge. FT for an as-spun sample shows the amorphous like and change to crystalline, which behaviour is similar Fe. In addition, by annealing at more than 793K, behaviour in peak strength and the peak position shows that like P. Therefore, it can be supposed that there is two phase transitions for Cu.

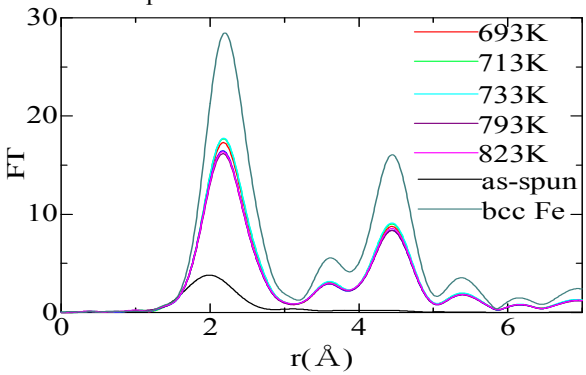

Fig. 1 FT of Fe *K*-edge EXAFS

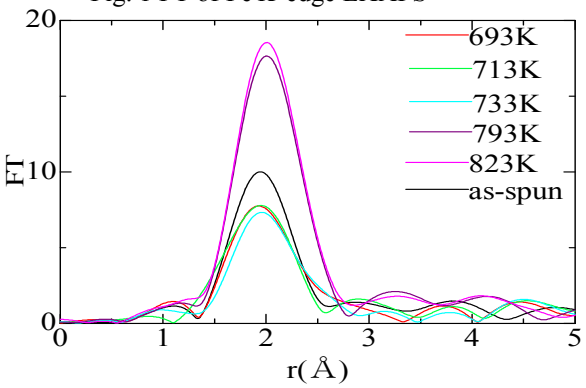

Fig. 2 FT of P *K*-edge EXAFS

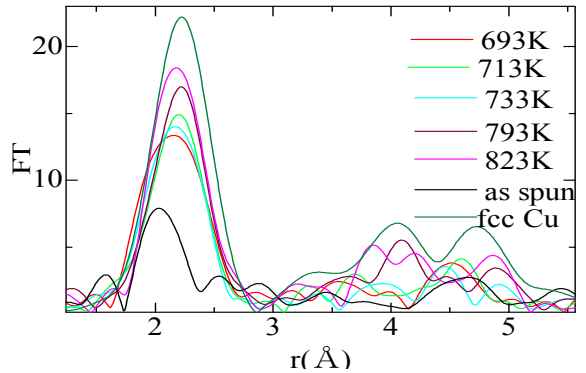

Fig. 3 FT of Cu *K*-edge EXAFS

References

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