

Soft X-ray fluorescence spectroscopy of $\text{Fe}_x\text{Co}_{1-x}\text{Si}$

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Introduction

Owing to the recent progress of evaporation technology, a novel growth mode of Al on Si(111) has been reported [1]; with a slight Al deposition, sub-monolayer or a few, well-ordered triangle islands were formed, which prevent subsequent Fe deposits from forming a silicide. In order to understand how the formation is prevented, first we tackle another extreme, *i.e.*, silicide itself.

The pseudobinary alloys of $\text{Fe}_x\text{Co}_{1-x}\text{Si}$ (Fe-Co silicide) exhibit weak itinerant ferromagnetism above a certain critical field in the concentration range of $0.2 < x < 0.95$ [2], and with increasing Co concentration ($1-x$), the alloys have a more itinerant character [3]. Indeed, FeSi ($x=0$) is an insulator, whereas most of $\text{Fe}_x\text{Co}_{1-x}\text{Si}$ alloys are metal.

In this report, we show the Si $2p$ soft X-ray fluorescence (SXF) spectra of these alloys and discuss about the influence of the itinerant character on the SXF spectra.

Experiment

SXF spectra were observed at BL-19B of KEK-PF. The measurements were carried out under room temperature and ultrahigh vacuum of less than 3×10^{-7} Pa. Si $2p$ SXF spectra were recorded using a 300l/mm bent grating having a 5m radius with a 100 μ -input-slit. $\text{Fe}_x\text{Co}_{1-x}\text{Si}$ samples were previously prepared by Watanabe *et al.* using a plasma-jet-flame furnace [2,3]. The samples were less oxidized and quite stable. Owing to the advantage of the depth probing power of SXF utilizing synchrotron radiation as an excitation light, no sample cleaning procedure in the chamber was required.

Results and Discussion

Figure 1 shows the Si $2p$ SXF spectra measured for $\text{Fe}_x\text{Co}_{1-x}\text{Si}$ alloys of $x = 0.07, 0.42, 0.61$ and 1. Incident photon energy was 131eV. Two broad peaks labeled A and B are observed at emission energies of 90.5 eV and 94.8 eV for all samples. The relative intensity of the peak B compare to the peak A is strongly enhanced with increasing Co concentration ($1-x$). The electronic characters of these two peaks are essentially the same as those of the peaks observed in SXF spectra of amorphous $\text{Fe}_{1-x}\text{Si}_x$ [4]. Imazono *et al.*, have associated the main peak, which corresponds to the peak A in Fig.1, with non-bonding Si $3s$ orbital and the shoulder feature, which corresponds to the peak B in Fig.1, with Fe $3d$ orbital. In our case, the peak B is associated with transition-metal $3d$ orbital. The lattice constant of FeSi is larger than that of CoSi by one percent [3] and also $3d$ electron number of FeSi is fewer

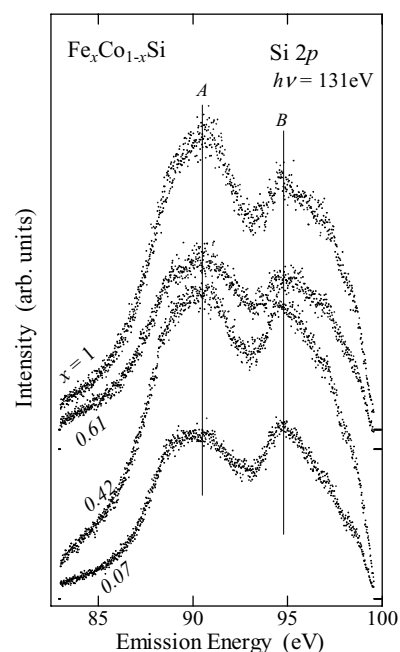


Fig. 1 Si $2p$ SXF spectra of $\text{Fe}_x\text{Co}_{1-x}\text{Si}$ ($x = 0.07, 0.42, 0.61, \text{ and } 1$). The vertical lines A and B are guides to the eye.

by one than that of CoSi, therefore the overlap of $3d$ orbitals onto the Si sites is reduced and the s -orbital peak A becomes narrow. Namely, with substituting Fe with Co, the numbers of $3d$ electrons gradually increase and the alloys become more itinerant. As a result, the intensity of the peak B increases.

Summary

The Si $2p$ SXF spectra of several $\text{Fe}_x\text{Co}_{1-x}\text{Si}$ alloys were measured. The x -dependence of characteristic peaks were observed, which were interpreted within the framework of an itinerant-electron system.

References

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