

Nuclear Resonant Small-Angle Scattering of FeB Alloys

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Introduction

The nuclear forward scattering (NFS) is powerful technique to measure the hyperfine fields of the nuclear. On NFS measurement, we can use the X-ray optical technique. It is the advantage over the other hyperfine field measurement techniques. On this study, we used small-angle scattering technique with NFS. From the nuclear resonant small-angle scattering, we can obtain the information of the hyperfine field from the specific size scattering material [1].

Experimental Procedure

The experimental arrangement is shown in Fig. 1. It is typical setting of Bonse-Hart camera. The energy of the synchrotron radiation was tuned into 14.4 keV and monochromatized into 6.4 meV width by the high-resonance monochromator. The angular profiles were measured by the rotation of second Si111 crystal. The photons were detected by the Avalanche Photo Diode (APD), which is fast X-ray detector.

The sample was Fe₈₀B₂₀ amorphous ribbon annealed in 0.2 hours at 400°C and 550°C to precipitate small crystals. For sample preparation, we used ⁵⁷Fe 98% enriched iron.

Results and Discussion

The observed angular profiles are shown in Fig. 2. On the both profiles, the nuclear resonant scatterings show additional scattering (small-angle scattering) to the electronic scattering. Applying the external magnetic field, additional scattering disappear, so this scattering due to magnetic structures. The cross section of the nuclear resonant scattering is different by the direction of the magnetic moments, so small-angle scattering of the magnetic domains is observed. The nuclear scattering of 400°C annealed sample shows steeper slopes than 550°C annealed sample around 50 μ rad. This result shows that

the nuclear resonant small-angle scattering of 400°C annealed sample is due to smaller particles than 550°C annealed. The sizes of magnetic domains increase with the annealing temperature.

References

[1] Yu. V. Shvyd'ko et al., Phys. Rev. B, 54, 14942 (1996).

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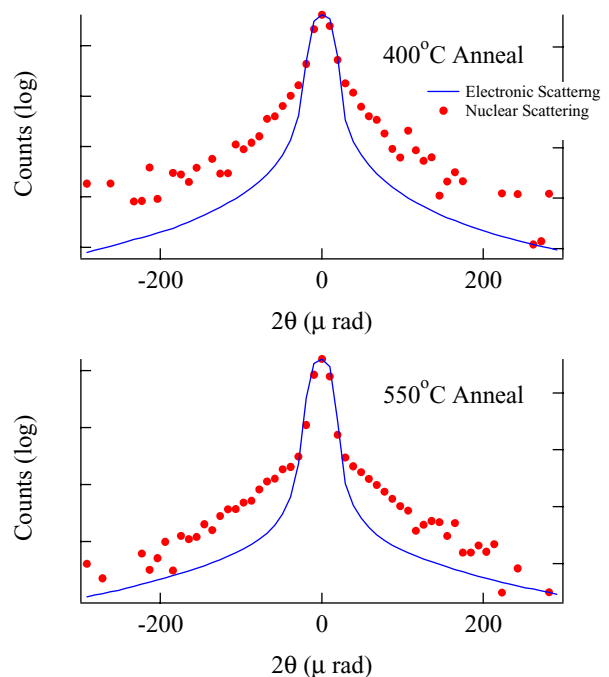


Fig. 2. Angular profiles the 400°C and 550°C annealed samples.

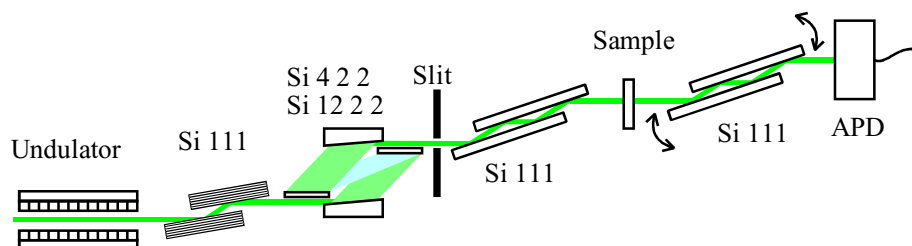


Fig. 1. Schematic drawing of experimental arrangement. Components are not in scale.