NE-3/2001G267

Nuclear Resonant Scattering of Amorphous Alloys

Yasuhiro KOBAYASHI[*1], Makoto SETO[1], Shinji KITAO[1], Rie HARUKI[2], ZHANG Xiaowei[2]
[1]Research Reactor Insttute, Kyoto University, Kumatori, Osaka 590-0494, Japan
[2]KEK-PF, Tsukuba, Ibaraki 305-0801, Japan

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 $Fe_{80}B_{20}$ amorphous ally annealed in 0.2 hours at 450°C to precipitate small crystals. For sample preparation, we used ^{57}Fe 98% enriched iron.

Results and Discussion

The observed angular profiles are shown in Fig. 2. On the profiles with the external magnetic field, the nuclear resonant scattering shows same angular profile as the electronic scattering. On the profile without magnetic field, the nuclear resonant shows broad profile. The cross section of the nuclear resonant scattering is different by the direction of the magnetic moments. This result shows the existence of the scattering by magnetic structure. From the Guinier plot of the data without magnetic field, the radius of the scattering material is estimated at 1.4 μm. From the size, the scattering is probably due to the magnetic domain walls [2].

We will measure the time spectra of NFS at small angle scattering (2θ = 100 μrad) to estimate the hyperfine field at scattering elements.

References

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*ykoba@rri.kyoto-u.ac.jp

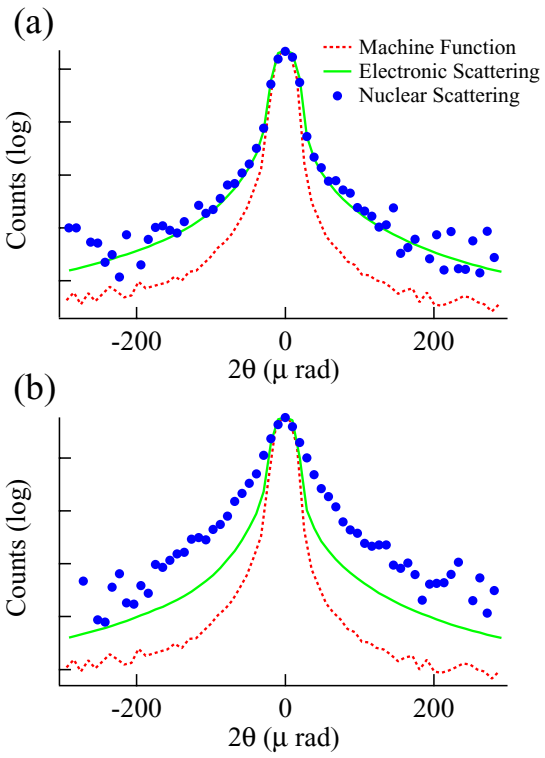

Fig. 2. Anguler profiles the sample (a) with external magnetic field (0.35T) and (b) without field.

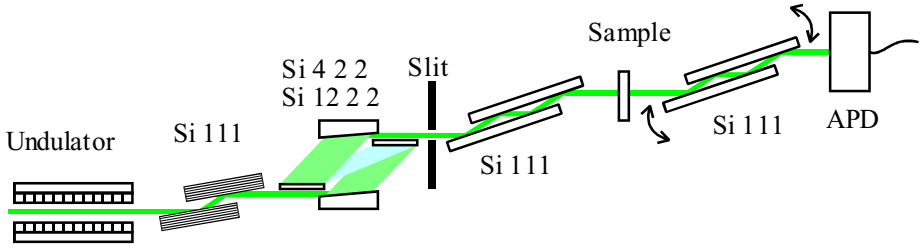

Fig. 1. Schematic drawing of experimental arrangement. Components are not in scale.