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Barium hexaferrite $BaFe_{12}O_{19}$ is ferrimagnetic and has the strong uniaxial magnetic anisotropy. Substitution of some Fe ions by non-magnetic ions results the reduction of the axial anisotropy along the c axis and it makes the substituted Barium-ferrite an attractive material. Our group has reported in the previous paper that we succeeded to observe a magnetic satellite reflection of $BaCoTiFe_{10}O_{19}$ at Fe K edge [1]. The observation verified that the Fe K edge can excite resonantly but indirectly the 3d state of iron and the magnetic resonant enhancement is sufficiently large to study the magnetic order of Fe compounds. In this study we have investigated the magnetic anisotropy change due to the substitution of $BaCoTiFe_{10}O_{19}$ by XMCD and RXMS method at Fe K edge. RXMS experiments were carried out at the BL-3A/6C of Photon Factory. X-rays were circularly-polarized by a transmitted-type phase retarder. Diffraction profiles were measured at wavelengths of λ = 1.7406 and 1.7390 Å. Low-temperature experiments at T = 100 K were performed with the Oxford Cryostream Cooler. The magnetic structure can be determined based on the difference between observed and calculated asymmetry ratios. The observed asymmetrical ratio ΔR_{obs} was obtained for 32 Bragg reflections through the RXMS measurements. The ΔR_{calc} was estimated from the crystal structure factors related to charge, anomalous, magnetic and resonant magnetic scattering terms, based on the structural model. The canting angles of spins were estimated with residual factors of $\Sigma(\Delta R_{obs} - \Delta R_{calc})^2$. The non-collinear spin structure of $BaCoTiFe_{10}O_{19}$ and magnetic anisotropy change due to the substitution will be disscussed.

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Keywords: doped ferrites, magnetic structures, X-ray resonant scattering

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Evidence of heterogeneous nucleation of $Nd_2Fe_{14}B$ upon crystallisation of Nd-Fe-B melt-spun ribbons

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This work studies the crystallisation behaviour of melt-spun $Nd_5Fe74B_{18}Cr_3$ nanocomposite magnets. Previous studies [1, 2] showed that the formation of $Nd_2Fe_{14}B$ can be promoted by flash annealing. Our study suggests that an orientation relationship exists between the $Nd_2Fe_{14}B$ and t-Fe_3B. An example of this is shown in Fig. 1. Several other interfaces were examined to consolidate our finding that the orientation relationship of <110>t-Fe_3B//<110>$Nd_2Fe_{14}B$ exists in the flash annealed ribbon. A similar orientation relationship was previously reported by Tomida et al. [3]. Our work confirms that $Nd_2Fe_{14}B$ forms via heterogeneous nucleation and that its orientation is related to t-Fe_3B.

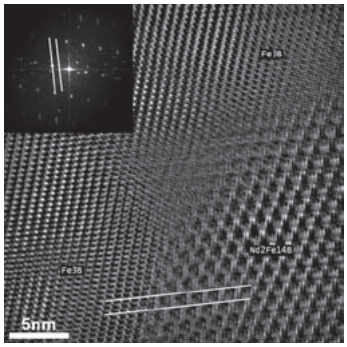

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Fig. 1: A Fourier-filtered high resolution TEM image of adjacent $Nd_2Fe_{14}B$ and t-Fe_3B grains in a nanocrystallised melt-spun Nd-Fe-B ribbon.

Keywords: nucleation and crystal growth mechanisms, nanocrystalline materials, amorphous crystalline transition

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Resonant X-ray scattering study on the cation distribution of $BaTiAFe_{10}O_{19}$ (A=Mn,Co)

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The site occupancy of Ti, Mn, Fe and Co ions among five independent Fe sites of M-type barium hexaferrites has been determined by the resonant x-ray scattering method, which uses the difference in anomalus scattering factor f' and is a useful tool to determine the site occupancy among the atoms having similar atomic numbers. The magnetic anisotropy of the end-member $BaFe_{12}O_{19}$ becomes suitable for perpendicular magnetic recording and microwave absorbers when it is optimized by substituting Fe^{3+} ions for several magnetic and/or non-magnetic ions. The hexagonal ferrite structure has tetrahedral $4f_1$, bipyramidal 2b, and octahedral 2a, $4f_2$ and 12k sites. It is reported that the ordering temperature and saturation magnetization are different between types of doping atom and the magneto-crystalline anisotropy may be correlated to the substitution on the bipyramidal site. Thus, it is important to determine the site occupancy of such ions as Ti, Mn and Co for the M-type barium ferrites. Single crystals of $BaTiCoFe_{10}O_{19}$ and $BaTiMnFe_{10}O_{19}$ ferrites were synthesized to cool slowly the powder crystals for 10 days from T = 1623 K. Conventional and synchrotron x-ray diffraction experiments were carried out using Rigaku AFC-7R and PF-BL10A four-circle diffractometers, respectively. The structural parameters of $BaTiAFe_{10}O_{19}$ (A=Mn, Co) were determined using the Mo Kα data by a full-matrix least-squares software, RADY. The site occupancy of Fe and Co ions was determined with the anomalous scattering effects at wavelengths of λ = 1.7480 and 1.6132 Å, while that of Ti ions was determined based on the data set measured with Mo Kα radiation. The relationship between the occupancy parameters and structural characteristics will be discussed.

Keywords: ferrites, resonant scattering, cation distribution