Effects of bismuth substitution on $Tb_{3-x}Bi_xFe_5O_{12}$

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(Presented on 9 January 2007; received 6 November 2006; accepted 12 December 2006; published online 2 May 2007)

The crystallographic and magnetic properties of $Tb_{3-x}Bi_xFe_5O_{12}$ ($x=0.5$, 0.75, 1.0, and 1.25) powders were studied using x-ray diffraction, vibrating sample magnetometer, and Mössbauer spectroscopy. The crystal structure of the samples is determined to be normal cubic structure $Ia3d$ by Rietveld refinement. The temperature dependence of magnetization with increasing bismuth concentration from $x=0.5$ to $x=1.25$ showed the decrease of compensation temperature from 177 to 107 K. Moreover, the field-cooled magnetizations of all samples show negative magnetization below the compensation temperature. We suggest that the negative magnetization is related to the local anisotropy by the strong covalent interaction between bismuth and iron. The isomer shifts obtained from Mössbauer spectra at room temperature of the (16*a*) and (24*d*) sites are about 0.26 and 0.04 mm/s, respectively, for all samples, which means that the irons at the (24*d*) site have a strong covalent interaction with bismuth. The Néel temperature increased from 616 to 655 K with increase of bismuth concentration from $x=0.5$ to $x=1.25$. Also, the saturation magnetization at room temperature increases linearly with increase of bismuth concentration. These behaviors can be explained by strong exchange interaction between *a* and *d* sublattices with increase of bismuth concentration. [DOI: 10.1063/1.2711394]