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Giant Magnetoelectric Effect in a Multiferroic Material with a High Ferroelectric Transition Temperature

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We present a unique example of giant magnetoelectric effect in a conventional multiferroic $HoMnO_3$, where polarization is very large (~56 mC/m^2) and the ferroelectric transition temperature is higher than the magnetic ordering temperature by an order. We attribute the uniqueness of the giant magnetoelectric effect to the ferroelectricity induced entirely by the off-center displacement of rare earth ions with large magnetic moments. This finding suggests a new avenue to design multiferroics with large polarization and higher ferroelectric transition temperature as well as large magnetoelectric effects.

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Structural and Magnetic Properties of Terbium Iron Garnet Thin Films Deposited by Pulsed Laser Deposition

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Multiferroics materials which exhibit more than one ferroic state, have been explored quite extensively in past several years. Very recently, low-field (H < 2 kOe) magnetodielectric (MD) effect over a wide temperature range has been observed in single crystal terbium iron garnet ($Tb_3Fe_5O_{12}$, TbIG).[1] The λ_{111} magnetostrictive coefficients in case of TbIG (deduced from the distortion of the lattice from cubic symmetry at 300 K toward rhombohedral symmetry at low temperature) reach $+2420\times10^{-6}$ at 4.2 K.[2]

This large Magnetostriction along (111) is responsible for Magnetodielectric (MD) effect in TbIG. In the present work, we deposited TbIG thin films on (110) single crystal gadolinium gallium garnet (GGG) substrate using pulsed laser deposition. The depositions were carried out in pure oxygen atmosphere at 0.16 mbar and 750°C of substrate temperature. X-ray diffraction (XRD) of these films shows (110) oriented growth of TbIG (Figure 1). The in-plane epitaxial orientation has been investigated using ϕ-scans in high resolution x-ray diffraction (HRXRD). The full width at half maximum (FWHM) value of 0.09° for (100) reflection in ϕ-scan, shows a high quality growth of TbIG thin film which has also been confirmed by atomic force microscope (AFM). The detailed study of magnetiztion and MD properties are under investigation and will be presented in the paper.

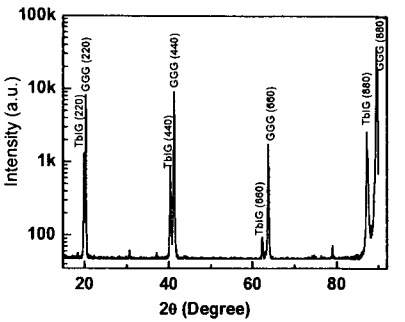

Fig. 1. XRD pattern of TbIG thin films deposited on GGG (110) substrate

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