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Monali Mishra, Amritendu Roy, Ashish Garg, Rajeev Gupta, Somdutta Mukherjee

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Room temperature multiferroism in polycrystalline thin films of gallium ferrite

Monali Mishra[1], Amritendu Roy[2], Ashish Garg[3], Rajeev Gupta[4,5] and Somdutta Mukherjee[1,*]

[1] Colloids and Materials Chemistry Department, CSIR-IMMT Bhubaneswar-751013, India
[2] Minerals, Metallurgical and Materials Engineering, Indian Institute of Technology, Bhubaneswar-751007, India
[3] Materials Science and Engineering, Indian Institute of Technology, Kanpur-208016, India
[4] Department of Physics, Indian Institute of Technology, Kanpur-208016, India
[5] Materials Science Programme, Indian Institute of Technology, Kanpur-208016, India

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Abstract

We have synthesized (010) textured polycrystalline thin films of gallium ferrite ($GaFeO_3$ or GFO) on n-Si(100) and Pt/Si(111) substrates using sol-gel assisted spin coating technique. Structural characterization using x-ray diffraction and Raman spectroscopy confirms formation of single phase with crystallite size ~37-47 nm. Magnetic characterization demonstrates saturated magnetic hysteresis loop at room temperature and indicates that due to reduced crystallite size, ferri to paramagnetic transition temperature, T_C ~300 K is higher compared to bulk GFO, reported earlier. Room temperature piezo-response force microscopic analysis reveals local ~180° phase switching of ferroelectric domains at very high coercive field, ~700 kV/cm, consistent with recent experimental and first-principles studies. Our study opens up the possibility of integrating polycrystalline GFO in novel room temperature multiferroic devices.

Introduction

Multiferroics are considered as the next generation digital memory materials owing to their unique attributes such as low energy consumption, fast read-write operation and extraordinary memory storage capability. [1, 2] Unfortunately, room temperature multiferroics are rare due to competing requirements of ferroelectricity and magnetism.[3] The most extensively studied room temperature multiferroic, bismuth ferrite ($BiFeO_3$)[4] demonstrates weak/no net magnetization at room temperature limiting its application potential. Thus, search for newer multiferroics with appreciable room temperature properties

Corresponding author: msomdutta@gmail.com