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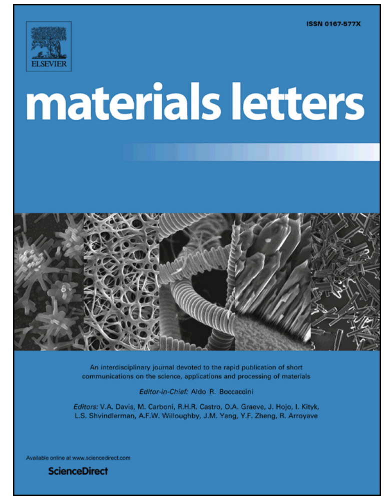

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Effect of annealing on the magnetic properties of zinc ferrite thin films

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Abstract

We report on the magnetic properties of zinc ferrite thin film deposited on $SrTiO_3$ single crystal using pulsed laser deposition. X-ray diffraction result indicates the highly oriented single phase growth of the film along with the presence of the strain. In comparison to the bulk antiferromagnetic order, the as-deposited film has been found to exhibit ferrimagnetic ordering with a coercive field of 1140 Oe at 5 K. A broad maximum, at ≈105 K, observed in zero-field cooled magnetization curve indicates the wide grain size distribution for the as-deposited film. Reduction in magnetization and blocking temperature has been observed after annealing in both argon as well as oxygen atmospheres, where the variation was found to be dependent on the annealing temperature.

Keywords: Annealing, Magnetization, Thin films, Epitaxial growth, Oxygen vacancies

1. Introduction

Spinel ferrites, AB_2O_4, generally exhibit cubic spinel structure, where oxygen anions reside at fcc lattice sites and cations occupy the tetrahedrally and octahedrally coordinated interstitial sites forming A and B sublattices [1]. These materials can have normal, inverse and mixed spinel structures and possess different kind of magnetic characters (ferrimagnetic, antiferromagnetic and paramagnetic) depending on the nature of cations and their distribution among different sites[1, 2]. The zinc ferrite ($ZnFe_2O_4$) has been proposed to be a candidate for spintronic applications, and various studies have been carried out on its magnetic and electrical properties[2, 3, 4, 5, 6, 7, 8, 9]. Bulk zinc ferrite, in perfect oxygen stoichiometry, is known to exhibit normal spinel structure with all Zn^{2+} and Fe^{3+} ions occupying the tetrahedral and octahedral sites, respectively and exhibits antiferromagnetic ordering below 10.5 K [2]. However, nanoparticles [4, 5] and thin films of $ZnFe_2O_4$ [6, 7, 8, 9] are reported to have the ferrimagnetic order. This is normally attributed to the placement of iron and zinc ions at both the sites, altering the spinel structure from normal to mixed state and inducing strong negative J_{AB} interactions between iron ions [10, 11, 12]. Apart from this redistribution of cations, the oxygen vacancy concentration is also believed to play a crucial role in controlling the magnetic properties of zinc

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