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Harish Sharma Akkera, Davinder Kaur

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Exchange bias effect in $\text{Ni}_{50}\text{Mn}_{35}\text{In}_{15}/\text{BiFeO}_3$ heterostructure thin film

Harish Sharma Akkera ^{a,b,*}, Davinder Kaur ^a

^aFunctional nanomaterials research lab, Department of physics, Indian Institute of Technology Roorkee, Uttarakhand - 247667, India

^bDepartment of Physics, Indian Institute of Science, Bangalore, Karnataka-560062, India

ABSTRACT

In this study, we studied the exchange bias (EB) effect in $\text{Ni}_{50}\text{Mn}_{35}\text{In}_{15}$ and $\text{Ni}_{50}\text{Mn}_{35}\text{In}_{15}/\text{BiFeO}_3$ heterostructure thin films deposited onto Pt/Ti/SiO₂/Si substrate using dc/rf magnetron sputtering. In pure $\text{Ni}_{50}\text{Mn}_{35}\text{In}_{15}$ film, the shift of the hysteresis loop from the origin up to 110 Oe was observed at 10 K due to coexistence of FM-AFM interface. On the other hand, the shift of the hysteresis loop was significantly enhanced (480 Oe) in $\text{Ni}_{50}\text{Mn}_{35}\text{In}_{15}/\text{BiFeO}_3$ heterostructure thin film at 10 K in field cooled. Further, a high exchange bias field of 80 Oe was found at room temperature in $\text{Ni}_{50}\text{Mn}_{35}\text{In}_{15}/\text{BiFeO}_3$ heterostructure thin film. The observed exchange bias field (H_E) in this heterostructure thin film was attributed to the presence of a pinned and uncompensated spins in the antiferromagnetic at the interface, and induced by the interface exchange coupling between $\text{Ni}_{50}\text{Mn}_{35}\text{In}_{15}$ and BiFeO_3 . This behaviour is an additional property for the $\text{Ni}_{50}\text{Mn}_{35}\text{In}_{15}/\text{BiFeO}_3$ heterostructure thin film to be used in various other magnetic memory device applications.

Keywords: Sputtering; Magnetic materials; Exchange bias

*email: ah.sharma75@gmail.com

1. Introduction

Exchange bias phenomenon (EB) was first discovered by Meiklejohn and Bean [1] in ferromagnetic/antiferromagnetic (FM/AFM) system in 1956 and has been extensively studied for their potential applications in spintronic devices [2], ultra-high density magnetic recording media [3], and many other magnetic materials [4] etc. The EB behaviour has been extensively studied in a several variety of composite materials such as the FM/AFM bilayer thin films [5-6], nanoparticles [7], and spin glass systems [8]. However, the likely EB effect in (FM) $\text{Ni}_{50}\text{Mn}_{35}\text{In}_{15}/$ antiferromagnetic (AFM) BiFeO_3 heterostructure thin film has not been reported yet. BiFeO_3 (BFO) is the only material whose ferroelectric Curie temperature ($T_C = 1103$ K) and antiferromagnetic Néel temperature ($T_N = 643$ K) are much higher than room

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