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Proccessing of PZT-Co base Magnetic Ferrite Multiferroic Nanocomposite Thin Film

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A thesis submitted to the Graduate Studies Office in partial fulfillment of the requirements for the degree of Ph.D.
in

Nanotechnology- Materials Engineering

June 2014

Abstract

Multiferroic effect is a new phenomenon considered recently that its fundamental and applicable investigations are under development in the world. Nowadays, progressing of theoretical investigation of multiferroics has resulted in development of new materials and components in this regards. Magnetoelectric multiferroic compounds have an application in device for transferring the magnetic energy to electrical energy and vice versa. In this research, multiferroic nanocomposite thin films consisted of cobalt ferrite, $Co_xFe_{2\pm x}O_4$ (CFO), with magnetostriction property and lead zirconate titanate, $Pb(Zr,Ti)O_3$ (PZT), with piezoelectric property in bilayer structure have been investigated that are prepared by pulsed laser deposition (PLD) method. The goal of this research is investigation of effect of cobalt ferrite composition on magnetoelectric effect of thin films consisted of CFO and PZT that they investigated by XRD, XANES, VSM, SQUID, AFM, MFM, PFM, VFM-PFM, and P-E tester. At first, CFO and PZT single layer were deposited on Pt(111)/Si substrates and optimum conditions of their preparation were obtained. CFO layers have perfect (111)-orientation and show strong in-plane magnetic anisotropy that is resulted from orientation and residual stress. Comparing to the stoichiometric CoF_2O_4 compound, the $Co_{0.8}Fe_{2.2}O_4$ compound has a higher saturation magnetization and coercivity. It is determined that the in-plane magnetic anisotropy of PZT/CFO bilayers is stronger than their corresponding CFO single layers, and this is more visible in PZT/$Co_{0.8}Fe_{2.2}O_4$ sample. The reason of enhancement of in-plane magnetic anisotropy in CFO layer by deposition of PZT top layer is increasing of residual stress of CFO layer. Magnetoelectric effect of PZT/CFO bilayers at nanoscale was verified using piezoresponse force microscopy (PFM) in the presence of variable magnetic field (VFM). In addition, investigation of polarization in the PZT/CFO bilayers by applying the magnetic field showed that variation of polarization in PZT/$Co_{0.8}Fe_{2.2}O_4$ sample is higher than that in PZT/$CoFe_2O_4$ sample, which can be resulted from higher magnetostriction of $Co_{0.8}Fe_{2.2}O_4$ compound. Furthermore, variation of polarization by applying the magnetic field in PZT/$Co_{0.6}Mn_{0.2}Fe_{2.2}O_4$ sample is higher than that for other samples, which can be due to the increase in the magnetostriction sensitivity of $Co_{0.8}Fe_{2.2}O_4$ compound by substitution of Mn.