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Irradiation enduced In-plane magnetization in Fe/MgO/Fe/Co multilayers

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For present investigation Fe/MgO/Fe/Co multilayer stack is grown on Si substrate using e-beam evaporation in ultrahigh vacuum. This stack is irradiated perpendicularly by 120 MeV Ag^{8+} at different fluences ranging from 1×10^{11} to 1×10^{13} ions/cm^2 in high vacuum using 15UD Pelletron Accelerator at Inter University Accelerator Centre, New Delhi. Magnetic measurements carried out on pre and post irradiated stacks show significant changes in the shape of perpendicular hysteresis which is relevant with previous observation of re-orientation of magnetic moment along the direction of ion trajectory. However increase in plane squareness may be due to the modification of interface structure of stacks. X-ray reflectivity measurements show onset of interface roughness and interface mixing. X-ray diffraction measurements carried out using synchrotron radiation shows amorphous nature of MgO and Co layer in the stack. Peak corresponding body centered Fe [JCPDS-06-0696] is observed in X-ray diffraction pattern of pre and post irradiated stacks. Peak broadening shows granular nature of Fe layer. Estimated crystallite size is 22±1 nm for pre-irradiated stack. Crystallite size first increases with irradiation then decreases. Structural quality of these stacks was further studied using transmission electron microscopic measurements. Thickness from these measurements are 54, 36, 23, 58 and 3 nm respectively for MgO, Fe, MgO, Fe+Co and Au layers in the stack. These measurements envisage poor crystallinity of different layers. Interfaces are not clear which indicate mixing at interface. With increase fluence mixing and diffusion was increased in the stack. X-ray absorption spectroscopic measurements carried out on these stacks show changes of Fe valence state after irradiation along with change of O(2p)-metal (3d) hybridized state. Valence state change predicts oxide formation at interface which causes enhanced in-plane magnetization.

Keywords: Magnetization, ion irradiation, Fe/MgO/Fe/Co multilayered thin film

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Impedance Spectroscopy Analysis on the $LaAlO_3/Sr_xCa1-_xTiO_3/SrTiO_3$ Hetero-Oxide Interface System

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The presence of the conduction interface in epitaxial $LaAlO_3/SrTiO_3$ thin films has opened up challenging applications which can be expanded to next-generation nano-electronics. The metallic conduction path is associated with two adjacent insulating materials. Such device structure is applicable to frequency-dependent impedance spectroscopy. Impedance spectroscopy allows for simultaneous measurement of resistivity and dielectric constants, systematic identification of the underlying electrical origins, and the estimation of the electrical homogeneity in the corresponding electrical origins. Such unique capability is combined with the intentional control on the interface composition composed of $SrTiO_3$ and $CaTiO_3$, which can be denoted by $Sr_xCa1-_xTiO_3$. The underlying $Sr_xCa1-_xTiO_3$ interface was deposited using pulsed-laser deposition, followed by the epitaxial $LaAlO_3$ thin films. The platinum electrodes were constructed using metal shadow masks, in order to accommodate 2-point electrode configuration. Impedance spectroscopy was performed as the function of the relative ratio of Sr to Ca. The respective impedance spectra were analyzed in terms of the equivalent circuit models. Furthermore, the impedance spectra were monitored as a function of temperature. The ac-based characterization in the 2-dimensional conduction path supplements the dc-based electrical analysis. The artificial manipulation of the interface composition will be discussed towards the electrical application of 2-dimensional materials to the semiconductor devices in replacement for the current Si-based devices.

Keywords: Impedance Spectroscopy, 2-dimensional conduction path