INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

The new field of research termed as spintronics is in multidisciplinary domain and its success relies on a strong synergy between breakthroughs in basic science and industrial applications. With the recent advances in the development of various spintronics devices, it is very much essential to study the magnetic properties of those materials (metallic alloy thin films) that are commonly used in such applications. Among various magnetic thin films, CoFeB based thin films have been found to be one of the promising materials suitable for various spintronics applications in modern magneto-electronic devices due to their tunable magnetic properties.

In this context, a systematic investigation has been carried out in this thesis work on the effects of thickness, composition and temperature on the structural and magnetic properties of single-layer amorphous $Co_{80-y}Fe_yB_{20}$ (*t* nm) thin films with two different compositions [$Co_{40}Fe_{40}B_{20}$ (CoFeB442) and $Co_{20}Fe_{60}B_{20}$ (CoFeB262)] over a wide range of thicknesses (7 − 200 nm). All films were prepared on thermally oxidized Si substrates at ambient temperature by DC magnetron sputtering. Structural studies confirm the presence of amorphous structure in the as-deposited films. CoFeB films with $t \leq 20$ exhibit soft magnetic nature due to in-plane magnetization with uniaxial anisotropy, while for films with $t > 50$ nm, the soft magnetic properties are degraded due to transition of in-plane magnetization to dense stripe domain, which is induced by the increased effective magnetic anisotropy (K_{eff}) caused by stress accumulated during the deposition process. Temperature dependent K_{eff} showed a strong compositional dependent variation. High thermal stability of CoFeB films for both compositions was also evident from high temperature magnetization measurement.

Subsequently, CoFeB262 based trilayer [CoFeB262 (*y* nm)/[Cr,Ta (*x* nm)]/CoFeB262 (20 nm)] films with $y = 20$ and 100, and $x = 0 – 6$ were prepared to study the effect of spacer layer materials and their thickness, and temperature on the magnetic interactions between CoFeB262 layers having same domain structure ($y = 20$, symmetric) and different domain structures ($y = 100$, asymmetric). The shape of the *M-H* loops in trilayer films strongly depends on *x*, *y*, spacer material and temperature. For asymmetric films, the transcritical loop changes into rectangular one with the introduction of spacer layer. Magnetic domain images of asymmetric films demonstrate the change in domain structure from stripe domain to in-plane domain. Temperature dependent *M-H* loops for asymmetric trilayer films show the formation of additional steps with $x > 0.5$ for both spacer layer materials.

Finally, the effect of top CoFeB262 layer thickness on the magnetic properties of a thick bottom CoFeB262 (100 nm) layer through different spacer layer materials (Cr and Ta) in trilayer [CoFeB262 (100 nm)/[Cr,Ta (*x* nm)]/CoFeB262 (*y* nm)] films with $y = 2, 5, 10, 30$ and 50 nm, $x_{Cr} = 0.75, 2$ and $x_{Ta} = 1, 4$ was investigated. The shape of *M-H* loops in trilayer films transforms from transcritical loop to rectangular loop with enhanced soft magnetic properties due to strong magnetic coupling between CoFeB262 layers. The obtained results clearly confirm that the magnetic properties of thick CoFeB262 films with dense stripe domain could easily be tuned into in-plane magnetization by this simple trilayer films. This simpler and novel approach has been demonstrated and reported for the first time in this thesis work and resulting publication.

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