



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI  
SHORT ABSTRACT OF THESIS

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Programme of Study : Ph.D.

Thesis Title:

**The study of magnetic properties and magnetic interactions in amorphous magnetic multilayer thin films**

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**SHORT ABSTRACT**

Driven by technological applications, the study of thin films, interfaces, multilayer magnetism and magnetic interactions between ferromagnetic layers is one of the most active research areas from both fundamental and applied research points of view in recent years. With this connection, in this thesis we (i) study the effect of film thickness on the structural and magnetic properties of two different important amorphous  $\text{Co}_{40}\text{Fe}_{40}\text{B}_{20}$  (CoFeB) ( $x = 10 - 200$  nm) and  $\text{Fe}_{80}\text{Ta}_8\text{C}_{12}$  (FeTaC) ( $x = 5 - 100$  nm) alloy thin films over a wide range of thickness and (ii) investigate the effect of number of spacer layers ( $n$ ), spacer layer (SL) thickness ( $z$ ), ferromagnetic (FM) layer thickness ( $y$ ) and measurement temperature ( $T$ ) on tuning the magnetic properties of films at higher thicknesses by utilizing the multilayer structure, i.e.,  $[\text{FM} (y \text{ nm}) / \text{SL} (z \text{ nm})]_n / \text{FM} (y \text{ nm})$ .

Chapter 1 presents a brief introduction to the content of the thesis along with a review of literatures relevant to the present thesis work. The motivation, aim and organization of thesis work are also included at the end of this chapter. Chapter 2 covers the basics of magnetism, intrinsic properties of magnetic materials, magnetic anisotropy, magnetic domains and domain walls and interlayer coupling in multilayer thin films. In chapter 3, a short introduction of experimental methods and techniques used in the present thesis work is described. It comprises the fabrication of samples and characterization tools. Chapter 4 discusses the thickness dependent magnetic properties of single-layer amorphous CoFeB ( $x$  nm) films with  $x = 10 - 200$  nm at first and then tuning the magnetic properties of CoFeB films at higher thicknesses by utilizing multilayer structure of  $[\text{CoFeB} (y \text{ nm}) / \text{Ta} (z \text{ nm})]_n / \text{CoFeB} (y \text{ nm})$  with  $y = x/(n+1)$ ,  $y$  and  $z$  are the individual thickness of FM and SL layer in multilayer films,  $n$  is the number of SL. The temperature dependent magnetic properties of CoFeB thin films in the temperature range between 30 and 650 K at different thicknesses are also examined. The observed results revealed that the soft magnetic properties of thicker CoFeB films could be improved by utilizing the multilayer structure. However, the improvement strongly depends on  $n$ ,  $z$  and  $T$ . Chapter 5 focuses on the systematic investigation of effects of number of  $n$ ,  $z$  and  $T$  on the interlayer coupling between CoFeB layers, exhibiting stripe domain structure, and their influences on the magnetic properties at room temperature and in low temperature region (30 K – 300 K) in  $[\text{CoFeB} (100 \text{ nm}) / \text{Ta} (z \text{ nm})]_n / \text{CoFeB} (100 \text{ nm})$  films with  $z = 0 - 1.5$  and  $n = 0 - 4$ . To understand the modification in the magnetic properties of multilayer films, single-layer CoFeB films of nearly equivalent thickness are prepared, characterized and compared. Chapter 6 is meant for studying thickness dependent surface topography, magnetic properties and domain structures of single-layer  $\text{Fe}_{80}\text{Ta}_8\text{C}_{12}$  ( $x$  nm) films with  $x = 5 - 100$  nm and systematic investigations on the effect of number of  $n$ ,  $z$ , magnetic domains of FeTaC layers on the temperature dependent magnetization reversal behavior in multilayer films and their influences on the magnetic properties at room temperature and at lower temperatures (30 – 300 K) in multilayer  $[\text{FeTaC} (y \text{ nm}) / \text{SiO}_2 (z \text{ nm})]_n / \text{FeTaC} (y \text{ nm})$  films. The summary of conclusions drawn from the thesis work along with the future scope of research in these films is presented in Chapter 7. References and list of publications originated out of this thesis work and the publications from other collaborative research works are listed at the end of the thesis.