# The Effect of Nano-Defects on Ising Hysteresis in Ultra-Thin-Film

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## ABSTRACT

***In this work, we modeled the dynamic magnetic behavior in magnetic ultra-thin-film structure. We investigated magnetic properties and their dynamic magnetization switching (hysteresis) by means of Monte Carlo simulations with the inclusion of various types of defects at nano-scale level. Types of defects being considered were the vacancy defects, the static-dipole defects and the anti-ferromagnetic dopants to ferromagnetic defects at various concentrations. The Ising model was considered and the spin-flip algorithm was used to update the magnetic configurations. The dynamic magnetic profiles, i.e., the time-dependent magnetization and magnetic field were observed as varying the defect concentrations. From the results, at a fixed temperature and magnetic field frequency, with increasing the vacancy concentration, both the coercivity and the remanence reduced due to the weaker ferromagnetic interaction in the system. On the other hand, the static contamination caused asymmetry pattern of the hysteresis loop such that the magnetization along anti-parallel direction to those static defect reduced its magnitude significantly. Finally, the anti-ferromagnetic defects gave rise to the combination behavior between the ferromagnetic and the anti-ferromagnetic hysteresis loops, leading to a promising way to control the hysteresis loop which reflected both the ferromagnetic and the anti-ferromagnetic phenomena.***

**Key words:** Nanostructure, Hysteresis, Defects, Magnetic ultra-thin-films, Ising model, Monte Carlo

## INTRODUCTION

The ferromagnetic magnetic thin-film has been a subject of intensive interest and investigation in view of a broad range of applications, especially in recording applications featuring from high-magnetic anisotropies (Johnson et al., 1996; Murayama et al., 2000; Plumer et al., 2001). In addition, in terms of fundamental interest in understanding, that the physical mechanisms involved in those nano-scale systems are quite different from bulk properties, has become a topic of frequent investigating issues. For instance, the magnetic hysteresis shape of the system under an applied field in thin-films is thoroughly different from the bulk's at a set of fixed parameters. As a result, one may use the magnetic thin-film's behavior to obtain the magnetic hysteresis which is caused by the relaxation delay between the external magnetic field and the response magnetization, at a right shape and suit some desired technological applications, e.g., transformer and magnetic storage media.

However, the description of how the hysteresis and their influence on the magnetic properties of ferromagnetic thin-films are affected by the external applied field is not quite well set up due to the underlying complexity of the micro-structural influences. For examples, in determining the properties of real materials, the importance of defects (e.g., vacancy,