Abstract for an Invited Paper
for the MAR09 Meeting of
The American Physical Society

**Exchange interactions between soft ferromagnetic thin films and multiferroic $BiFeO_3$.**[1]

DELPHINE LEBEUGLE, Laboratoire de Physique des Solides, CNRS, Université Paris Sud, 91404 Orsay

Controlling the magnetization of a thin ferromagnetic (FM) film using an electric field is a Holy Grail of nowadays spintronics as it would revolutionize the addressing of magnetic memory elements. One strategy is to combine the magnetoelectric coupling of multiferroic materials like $BiFeO_3$ (BFO) [1] with the exchange coupling (EC) observed in FM / antiferromagnetic (AFM) systems such as in BFO/CoFeB bilayers [2]. BFO is a material of choice as it is one of the very few room-temperature AFM multiferroics. The two types of studied structures consist in FM layers of CoFeB deposited on BFO/STO films as well as thick permalloy layers sputtered onto BFO single crystals. They have been investigated by MagnetOptic Kerr Effect (MOKE) measurements. A macroscopic shift $H_E$ of the FM loops is a signature of exchange-bias (EB) in bilayers where the FM spins are coupled to the uncompensated AFM ones. We will show that the complex angular dependences of $H_E$ and $H_C$ result from the competition between the anisotropies of the FM and AFM layers and the strength of the EC. We will also compare the magnetic properties of the FM layers in relation with the ferroelectric structure of the underlying BFO. In their virgin state, the crystals are in a single ferroelectric and AFM domain with a cycloidal magnetic structure whereas thin films, in which the cyloid is suppressed, are in a highly multidomain state. This comparative study allows us to determine the nature and location of the spins involved in the mechanism of EC. Finally, we present the electric field effect on $H_E$ and $H_C$ of these systems. Our previous work on BFO crystals demonstrated that during electrical poling, any change of the polarisation direction induces a spin flop of the AFM moments. We will show here that a $90^\circ$ rotation of the anisotropy axes can be obtained in domains where the polarisation is electrically flipped.

[1] PRL, **100**, 227602 (2008).
[2] PRL, **100**, 017204 (2008)

[1]This research has been supported by the Agence Nationale de la Recherche, project "FEMMES" NT05-1 45147.