Switchable magnetization and polarization using multiferroics

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Multiferroic-based materials and heterostructures hold promises of potentially relevant functionalities. Most of them are based on the fact that these materials could show the ability of switchable ferroelectric polarization by a magnetic field or the magnetic polarization by an electric field. However, due to the weak coupling of both magnetic orders distinct approaches are required for each purpose. Interface coupling between multiferroics and ferromagnets appear to be a very promising tool to achieve sizable electric control of the magnetization. Coupling may be mediated by the exchange interaction between a multiferroic antiferromagnet and a suitable ferromagnet and it can express itself as an exchange bias field. Enormous progress has been achieved using this approach to modulate magnetization of the ferromagnetic layer. However, important issues remain to be addressed. For instance, the relative role of antiferromagnetic domains or domain walls as microscopic mechanisms of exchange bias, or the contribution of the accompanying strain effects associated to ferroelasticity. In this presentation we shall overview some of recent progress. It will be shown that using judiciously chosen materials, ferroelastic contributions can be avoided thus leading to purely electric effects on exchange bias and, in turn, on the magnetization of a neighbouring ferromagnetic layer. Moreover, we will show that switching and resetting of the exchange bias and magnetization can be done isothermally using appropriately shaped electric pulses. A framework for understanding these streaking effects will be discussed. On the other hand, switching the ferroelectric polarization by an appropriate magnetic field could also lead to novel applications. Most probably this would require using of thin films. Here we will show that magnetically switchable polarization is observed in YMnO3 thin films.