MAR12-2011-000594

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

Flexoelectricity in Nanoscale Ferroelectrics

GUSTAU CATALAN, ICREA and CIN2, Barcelona

All ferroelectrics are piezoelectric and thus have an intrinsic coupling between polarization and strain. There exists an additional electromechanical coupling, however, between polarization and strain gradients. Strain gradients are intrinsically vectorial fields and, therefore, they can in principle be used to modify both the orientation and the sign of the polarization, thanks to the coupling known as flexoelectricity. Flexoelectricity is possible even in paraelectric materials, but is generally stronger in ferroelectrics on account of their high permittivity (the flexoelectric coefficient is proportional to the dielectric constant). Moreover, strain gradients can be large at the nanoscale due to the smallness of the relaxation length and, accordingly, strong flexoelectric effects can be expected in nanoscale ferroelectrics. In this talk we will present two recent results that highlight the above features. In the first part, I will show how polarization tilting can be achieved in a nominally tetragonal ferroelectric ($PbTiO_3$) thanks to the internal flexoelectric fields generated in nano-twinned epitaxial thin films. Flexoelectricity thus offers a purely physical means of achieving rotated polarizations, which are thought to be useful for enhanced piezoelectricity. In the second part, we will show how the large strain gradients generated by pushing the sharp tip of an atomic force microscope against the surface of a thin ferroelectric film can be used to actively switch its polarity by 180°. This enables a new concept for "multiferroic" memory operation in which the memory bits are written mechanically and read electrically.