Nanoscale Ferroelectricity in Innovative Lead-Free Oxide Thin Films

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Many research groups in the world are hardly working on the development, synthesis and characterization of novel ferroelectrics to enhance functional properties for information storage, electronics and spintronics applications. These ferroelectrics include both organic and inorganic compounds. Regarding oxide inorganic materials and for environment, one of the objectives is to replace lead-based compounds such as $Pb(Zr_xTi_{1-x})O_3$ by lead-free compounds showing such as high ferroelectric performances. Further, with the development of nanotechnologies, many applications require 0D, 1D or 2D materials *i.e.*, for the latter, (ultra) thin film. On the macroscale, due to inherent phenomena such as leakage current, measurement of ferroelectric properties in such films can unfortunately be ineffective while suitable techniques and tools of atomic force microscopy can be operative at the sub-micron level.

In this talk, we will present inorganic oxide materials recently discovered, or/and highlighted, which reveal ferroelectricity at room temperature when they are grown in the form of thin film. We will particularly focus this presentation on $Ln_2Ti_2O_7$ lanthanide dititanates with double-perovskite structure and Ln_2WO_6 lanthanide tungstates.[1-3] We will demonstrate that strains induced by the substrate in the film can stabilize ferroelectric metastable phases. Besides, piezoresponse force microscopy is known as a powerful technique which permits to access to the domains pattern of ferroelectric sample while its spectroscopic tool yields information about switching properties (ferroelectric properties) and electromechanical activity (piezoelectric properties). We will demonstrate that carefully well-defined experiments have to be achieved to avoid any misinterpretation about existence of ferroelectricity. Some examples of non-ferroelectric compounds, such as $Nd_2Ti_2O_7/SrTiO_3$ superlattice, will be reported.[4] Phenomena explaining the non-ferroelectric behaviour in samples will be specified.[5,6]

We will conclude this presentation by showing that the fabrication of new artificial hybrid materials combining designed inorganic lead-free ferroelectric thin films and electro-active organic polymers can be promising for the emergence of new attractive applications.

Keywords: Lead-Free Oxides, Thin films, Ferroelectricity, Nanoscale, Atomic Force Microscopy

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