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# Electrical Tuning of Ferroelectric Mechanical Switching in PbZr0.2Ti0.8O3 thin films

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Research on ferroelectric (FE) domains and domain walls is of interest for its potential applications in novel nano-electronic devices. More specifically, the mechanical switching of FE domains by a local stress is a recent discovery that could be applied to design pressure sensors. Contrary to the electrical control of FE domains which is well known, the mechanical control is still in its infancy in most FE materials. To better understand the physical phenomena behind mechanical switching of FE polarization, different mechanisms must be taken into account including flexoelectricity, piezoelectricity and ferroelasticity. Furthermore, others factors such as FE synthesis and processing parameters, which affect the phases, interfaces, microstructure, polarization orientation, as well as the nature and distribution of defects must be considered.

Our work is focused on the mechanical stress applied to PbZr0.2Ti0.8O3 (PZT) chemical-solution-deposited thin films using an atomic force microscope tip. Our results suggest that mechanical switching of FE domains is possible for thickness from 33 to 200 nm and it is affected by the different synthesis processes (pyrolysis, crystallization). The interplay between electrical and mechanical stress is investigated by poling the samples electrically before mechanical stress. A multiscale structural and chemical analysis of the films by X-ray diffraction, scanning transmission electron microscopy and Rutherford backscattering spectrometry provides information on the structure and chemistry, within the films and at the interfaces.

Our results show that the switching threshold force scales with coercive voltage as a function of the film thickness. Moreover, the prior application of an electric film leads to an increase of the threshold force compared to the case where no electric field is used to switch domains. Finally, the mechanical switching process is affected by the presence of nm-size cavities in the film, either aligned or randomly distributed. We will discuss the possible mechanisms governing the mechanical switching of domains, with the aim of providing new clues to control the nanoscale FE-mechanical switching.

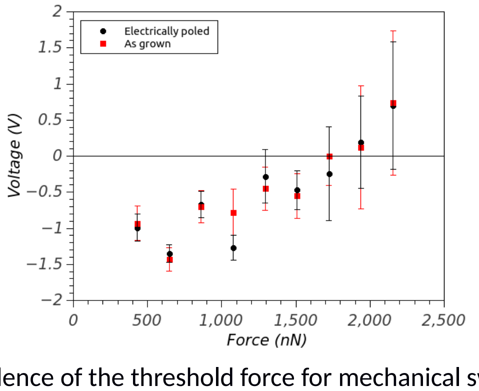


**Figure 1 :** Experimental evidence of the threshold force for mechanical switching in a 33 nm thick PZT film. The shift of the coercive voltage is represented as a function of the force applied with the AFM tip.