Interphase and domain wall motion in Ferroelectric Films as probed by in-situ X-ray Diffraction during Electrical Biasing

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Piezoelectric and ferroelectric thin films are ubiquitous in many applications such as sensors, actuators, pyroelectric devices or advanced memories. The case of polycrystalline thin films is particularly complex and delicate to model. Several effects (i.e. interface, substrate clamping, grain boundary, stress) affect the behavior of the domains at the local scale and by consequence impose the film macroscopic response.

It will be shown in this communication how in-situ X-ray diffraction during electrical biasing (DC or AC mode) offers unique information to address these complex behaviors at different scales. The case of the prototypal Pb (Zr_{48}, Ti_{52}) O_3 or PZT films will be discussed. These films at the morphotropic phase boundary (MPB) are composed of two textured ferroelectric phases (one tetragonal and the other rhombohedral). It has been observed that interphase boundary motion is the predominant effect during the biasing. A strong heterogeneity from grain to grain and as a function of the depth in the film has also been observed [1].

Our results are based a combination of synchrotron beamtimes as well as results from our in-situ lab source based setup [2]. Finally, the ability to image ferroelastic domains by coherent diffraction techniques (or CBDI) will be discussed.

[1] Vaxelaire et al *Jour.of Appl. Phys*. **120**, 104101(2016)
[2] Allouche *in preparation*

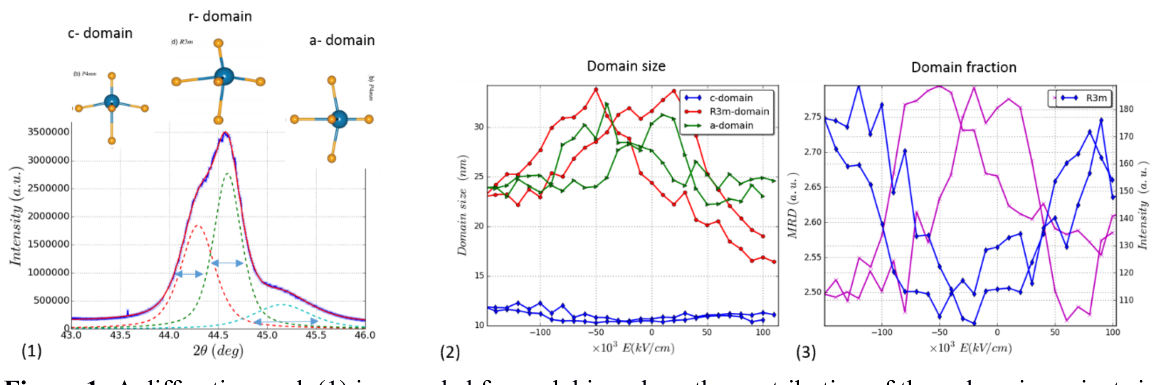

Figure 1: A diffraction peak (1) is recorded for each bias where the contribution of three domain variants is quantified. The FWHM (related in first approximation to the domain size) (2) and the intensity of the 3 variants (3) (related to domain fraction) present a typical butterfly shape as a function of the electrical field.