

Study of the electrical and electronic properties of domains and domain walls in ferroelectrics combining AFM and STEM techniques

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Controlling ferroelectric domains and domain walls appears as a promising new approach for enhancing the performance of electronic devices due to their unique electrical properties at the nanoscale. Recently, several orders of magnitude of resistivity difference has been measured between conducting domain walls and the bulk of the domains on selected ferroelectric materials [1][2][3][4]. These results may open the path to a new generation of memories or transistors taking advantage of such variations of electrical conductivity at the nanoscale [5].

Indeed, conduction in domain walls depends on different factors, including intrinsic ones as the nature and configuration of the domains and domain walls, and extrinsic ones as the environmental conditions or point defects. Moreover, the creation, movement and stability of domain walls strongly depend on the presence of defects in the material. Our work is placed in this framework, and we have investigated the electrical and electronic properties of different ferroelectric materials, including thin films of $\text{Pb}(\text{Zr}_{0.2}\text{Ti}_{0.8})\text{O}_3$, BiFeO_3 , and BaTiO_3 . Using the atomic force microscopy (AFM) and derived techniques (Piezoresponse Force Microscopy, Conducting-AFM), we have mapped and measured the local ferroelectric response and conductivity at natural and artificial domain and domain walls, and studied the different factors controlling the creation and manipulation of domains. We have combined these results with the high resolution imaging of these systems using aberration corrected scanning transmission electron microscopy (STEM). We will discuss these results with the aim to provide a larger understanding of means to exploit the localized conduction in integrated ferroelectric devices.

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