Big/deep Data Approaches for Investigations of the Tip-induced Ferroelectric Switching

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Ferroelectric materials are considered as a perspective platform for a wide range of practical application, such as such as sensors, microactuators, infrared detectors, microwave phase filters, data storage and processing devices. Scanning probe microscopy (SPM) has become a standard tool for complex study of the various ferroelectric materials. It allows both visualization and modification of the domain structures with the nanometer spatial resolution.

In this work, we considered the variety of domain morphologies produced by the scanning probe microscope tip on the polar and non-polar cuts of ferroelectric single-crystals. We performed analysis of their parameters based on the principal component analysis (PCA). It allowed gaining insights into the highly nontrivial process of the polarization reversal limited by the screening dynamics and provided descriptors of the domain shape. These descriptors are further used as inputs of the neural network for recognition of a wide range of the domain properties (e.g. shape of the switching pulse used during switching), which potentially enables novel approaches to the multilevel information storage and determination of the thermodynamic properties of the sample encoded in the features of the domain shape.

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