DF 1: Nano- and microstructured dielectrics

Time: Monday 9:30–10:30 Location: H11

DF 1.1 Mon 9:30 H11

Ferroelectric domains at the phase transition in $BaTiO_3$ — •Thorsten Limböck, Akos Hoffmann, and Elisabeth Soergel — Physikalisches Institut, Universität Bonn, Wegelerstrasse 8, 53115 Bonn

The classical example of a perovskite crystal, Barium Titanate ($BaTiO_3$), exhibits several phase transitions, namely from rhombohedral $\xrightarrow[-90^\circ]{}$ orthorhombic $\xrightarrow[+7^\circ]{}$ tetragonal $\xrightarrow[+120^\circ]{}$ cubic. In order to investigate the behavior of the ferroelectric domain patterns at the phase transition occurring at $+7^\circ$ we upgraded our scanning force microscope with a Peltier cooling/heating stage allowing for operation in a temperature range between -80° and $+120^\circ$. Piezoresponse force microscopy (PFM) images, directly mapping the ferroelectric domain configuration, can be acquired either at fixed temperature or, when using a custom-designed script, during temperature ramps linked to the scanning process. We can thereby record the emergence of the domains when cooling down from high temperatures but also the change of the domain patterns across the orthorhombic to tetragonal phase transition.

DF 1.2 Mon 9:50 H11

Properties of ferroelectric domain boundaries investigated with scanning force microscopy — Jakob Frohnhaus, •Akos Hoffmann, and Elisabeth Soergel — Physikalisches Institut, Universität Bonn, Wegelerstrasse 8, 53115 Bonn

In lithium niobate ($LiNbO_3$), the ferroelectric polarization can only occur along the $\pm z$ direction resulting in the well-known 180° domain boundaries ($\downarrow\uparrow$) which are generally used for applications such as periodically poled $LiNbO_3$ is used in nonlinear-optics. The two large faces of a z-cut crystal show the domain pattern as alternating $+z$, $-z$, $+z$, ... areas. Indeed, using a specific thermal treatment, also head-to-head domain boundaries ($\substack{\downarrow\\ \uparrow}$) can be generated. Obviously such a crystal exhibits only two domains, and consequently only one domain boundary, and the two large faces of a z-cut crystal are both $-z$-faces.

Scanning force microscopy (SFM) is known as a very versatile tool for highly resolved imaging not only of the surface itself but also of the materials' properties. It is therefore possible to detect not only the topography but also the surface charge density, the piezoresponse, the conductivity, ... with high lateral resolution. We apply the varieties of SFM for the investigation and modification of these very different domain boundaries.

DF 1.3 Mon 10:10 H11

Nanosecond laser-induced nano-structuring of fused silica — •Pierre Lorenz, Frank Frost, Martin Ehrhardt, and Klaus Zimmer — Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstraße 15, 04318 Leipzig, Germany

The nano structuring of dielectrics is a big challenge for laser patterning methods. The laser-induced front side etching method using in situ pre-structured metal layers (IPSM-LIFE) allows an easy and fast fabrication of nanostructures into dielectric surfaces. At the IPSM - LIFE process, the irradiation of thin chromium film deposited onto a dielectric substrate with low laser fluences results in the formation of complex metal structures by self-assembly processes. Further laser irradiation of these metal structures with higher or equal laser fluences causes the formation of complex patterns at the surface of the dielectric. The patterns observed after irradiation of chromium-covered fused silica with laser pulses (25 ns, 248 nm) were studied by scanning electron microscopy (SEM) and atomic force microscopy (AFM). The resultant dielectric surface structures was studied dependent on the laser parameter (number of laser pulses, laser fluences) and material parameter (metal layer thickness). Different features like concentric ring patterns, donut-like structures as well as bar patterns were observed. Lateral sizes down to 20 nm can be achieved.