

Investigation of piezoelectric effect in barium titanite thin films using piezoresponse force microscopy

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Piezoelectric effect in the nanoscale, especially in single crystals of piezoelectric materials, is getting attention of microelectronics researchers very quickly. It could be useful e.g. in data storage. In order to apply those materials (e.g. barium titanate) in the most optimal way, one have to completely analyze and diagnose the piezoelectric effect in materials of various thickness and composition. One of the most expected result of the research is calculating the piezoelectric constant of the material.

A perfect tool for the analysis of single piezoelectric domains is a contact-mode atomic force microscope, equipped with a conductive probe, in the presented set-up called also a piezoresponse force microscope (PFM), constructed at Wrocław University of Technology. The microtip of a PFM's probe acts as an electrode, while as the second electrode we use a metal layer deposited before the investigated one. Applying ac voltage between the electrodes causes mechanical oscillation in the piezoelectric layer. This oscillation is detected optically by a spring microcantilever, on which the tip is placed. The amplitude and phase of the oscillation are measured using a lock-in amplifier.

We present the construction of the PFM microscope and results of simultaneous measurements of the topography and piezoelectric response of the barium titanate layers (Fig. 1). Titanium electrode was vacuum-evaporated on top of a *p*-type Si (<100>, $\rho = 2-10 \text{ } \Omega\text{cm}$) substrate. Then approximately 100 nm thick barium titanate films were produced on metal using radio-frequency plasma sputtering (RF PS) method. In the paper we will describe fabrication process of the BaTiO_3 film and the investigation procedure including precise calibration of the applied PFM microscope.

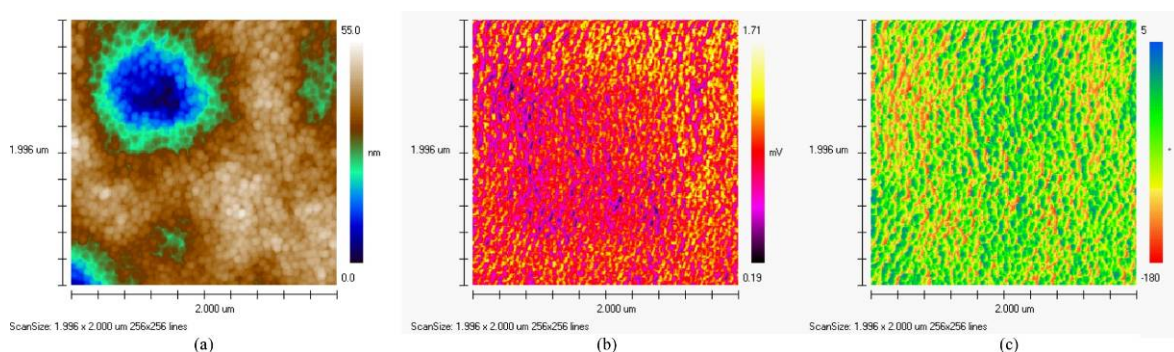


Figure 1. Result of a simultaneous measurement of: (a) topography, (b) module and (c) phase of the piezoelectric response of a BaTiO_3 film. Result of previous biasing can be seen in the middle image