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Determination of the Polarization Profile in Ferroelectrics by Means of TSWM

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According to Devonshire´s phenomenological theory, there is a close relation between spontaneous polarization and pyroelectric coefficient. Following Liu and Zook this relation can be derived as shown here in a general form. Consequently, when determining the pyroelectric coefficient profile, we obtain the spatial distribution of polarization.

In dynamic pyroelectric response measurement techniques, a modulated light beam is absorbed by the top electrode and generates a thermal wave travelling into the sample. The temperature change caused by the advancing thermal wave leads to the appearance of a pyroelectric current which is registered by an external measuring device.

Modulation of a light beam is mostly performed in two ways: sinusoidal modulation (Laser intensity modulation method - LIMM) and rectangular modulation (rectangular modulated light pulses). In the LIMM-method polarization profile reconstruction is carried using the pyroelectric current spectrum including the phase shift between pyroelectric response and the heat flux. In the Thermal square wave method (TSWM) developed at Tver State University, rectangular heat pulses provide a constant heating rate during pulse time. Consequently, changes in the pyroelectric current reflect changes in the pyroelectric coefficient.

Therefore, the reconstruction of the polarization depth profile can be made by analyzing the time dependence of the pyroelectric response.

TSWM was used to determine the polarization depth profile of undoped and doped ferroelectric single crystals and ceramics. Examples of strontium-barium niobate single-crystals doped with chromium and rare earth elements as well as PZT ceramics are considered. Additionally, the determination of the thermal diffusivity of thin films on top of a ferroelectric infrared sensor by means of TSWM is demonstrated.

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