Impulsinio lazerinio garinimo būdu užaugintų PZT epitaksinių sluoksnių elektrinės savybės

Electrical properties of epitaxial Lead Zirconate Titanate grown by Pulsed Laser Deposition

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Due to their high dielectric constant, piezoelectric and pyroelectric coefficients, ferroelectric materials are already being utilized in various applications such as high-k dielectric materials, transducers, actuators, and sensors [1]. Among many types of ferroelectric materials, lead zirconate titanate (PZT) is well known as a world-leading ferroelectric material for piezoelectric applications [2].

Still, thick PZT films with electrical characteristics comparable to the bulk equivalent are difficult to achieve, owing to crack formation lead and lead oxide volatility and a number of other flaws in thin film processing.

To solve those issues the technique of Pulsed Laser Depositions (PLD) was employed. PLD is a promising technique for PZT-film fabrication because it offers a high deposition rate (usually > 100 nm/h), high crystalline quality, and unaltered stoichiometry, as well as very good surface morphology which eases the fabrication of high-quality test structures devices such as plan-parallel capacitors.

The aim of this work is to investigate the dielectric and piezoelectric properties of PZT film by fabricating metal-ferroelectric-metal structures of epitaxial PZT films on a lanthanum strontium manganite (LSMO) with a top copper and gold contacts.

The polarization reversal (ferroelectric switching) within the sample is indicated by the positive and negative notable peaks of the measured current. A shift toward the positive side of the loop suggests that there is an internal field (Ein) directed toward the top electrode.

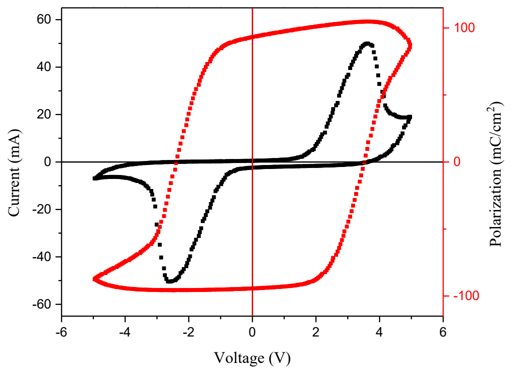

Fig. 1. Polarization and current hysteresis loops obtained for a LSMO/PZT/Cu/Au ferroelectric capacitor by applying a triangular voltage pulse with a frequency of 1 kHz.

The observed dispersions in high-frequency tails can be accurately modeled by the classical Cole-Cole functions. However, these functions fail to predict the low-frequency plateaus of ε and σ, and instead, a function of the constant phase-angle (CPA) type appears to provide a more accurate description of the data in the low-frequency region of the plots.

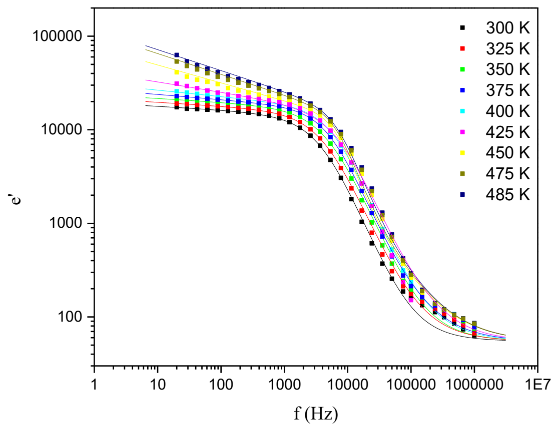

Fig. 2. Real part of the dielectric constant at different temperatures. The solid lines are fits of the data points with the Raicu relation (1).

Fit was made with this formula which also takes into account the contribution of dc conduction, which may be encountered experimentally at the low-frequency side, as proposed by Raicu.

$$\varepsilon(jw)=\varepsilon_\infty+\frac{\sigma}{jw}+\frac{\varepsilon(0)-\varepsilon_\infty}{[(jw\tau)^{\alpha}+(jw\tau)^{1-\beta}]^{\gamma}}. \quad (1)$$

Keywords: PZT, thin film, PLD, dielectric spectroscopy, piezoelectric measurement.

Reference

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