The Serbian Society for Ceramic Materials

Institute for Multidisciplinary Research, University of Belgrade

Institute of Physics, University of Belgrade

Center of Excellence for the Synthesis, Processing and Characterization of Materials for use in Extreme Conditions "CEXTREME LAB" - Institute of Nuclear Sciences "Vinča", University of Belgrade

Faculty of Mechanical Engineering, University of Belgrade

PROGRAMME and the BOOK of ABSTRACTS

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Zorica Branković
Dušan Bućevac
Vladimir V. Srdić

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ENHANCED LOCAL PIEZOELECRTIC RESPONSE IN Mn-DOPED $(K_{0.5}Na_{0.5})_{0.99}Sr_{0.01}NbO_3$ FILMS

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The interest for the lead-free materials rapidly increased after 2003, when the legislation against the use of lead-based piezoelectric materials in electronics had passed. Among the numerous lead-free materials, special attention was paid to some compositions of potassium sodium niobate solid solutions, $K_{0.5}Na_{0.5}NbO_3$ (KNN) obtained by a partial replacement of A- and B- site atoms from the perovskite KNN crystal lattice with dopants, which in the form of ceramic showed excellent piezoelectric and ferroelectric properties. Driven by the miniaturization and integration into sensors and energy harvesters, great efforts have been also made in processing of high quality KNN thin films.

In this contribution, the effects of the A-site doping of KNN films with Sr (KNN-xSr) on the microstructure and electrical properties were investigated for the first time. For that purpose, liquid precursors of $(K_{0.5}Na_{0.5})_{1-x}Sr_xNbO_3$ (KNN-xSr, x = 0, 0.005, 0.01) thin-films, were prepared from potassium and sodium acetates, niobium ethoxide and an appropriate amount of strontium nitrate in 2-methoxyethanol solvent with 5 mol% of potassium acetate excess. The approximately 250 nm thick KNN-xSr thin films on Pt(111)/TiO_x/SiO_2/Si substrates were obtained through repeated spin-coating and pyrolysis steps, followed by the rapid thermal annealing at 650 °C.

All KNN films crystallized in pure perovskite structure with (100) preferential orientation, which became more pronounced in doped films, as confirmed by the Lotgering factor. The addition of 1 mole% Sr dopant, however, effectively reduced the leakage current density to $4.2 \cdot 10^{-8}$ A/cm^2 at the electric field of 100 kV/cm and contributed to the well-saturated ferroelectric hysteresis loop of the film. The major drawback of this film was in the low piezoelectric response (a few pm/V measured by piezoresponse force microscopy) and inability to switch ferroelectric polarization by electric field, which can be related to the defects, such as oxygen vacancies. To overcome the problem, an improved synthesis of the KNN-1Sr films with 1 mole% Mn was introduced. The reasons for decrease in the leakage current density and improvement of piezoelectric response will be discussed.