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

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Branko Matović
Zorica Branković
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Dr Branko Matović
Dr. Zorica Branković
Dr. Dušan Bučevac
Prof. Vladimir V. Srdić

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B-SITE DOPING AS A STRATEGY FOR TAILORING $BiFeO_3$ PROPERTIES

Aleksandar Radojković[1], Danijela Luković Golić[1], Jovana Ćirković[1], Aleksandra Dapčević[2], Damir Pajić[3], Filip Torić[3], Zorica Branković[1], Goran Branković[1]

[1]*Institute for Multidisciplinary Research, University of Belgrade, Serbia*
[2]*Faculty of Technology and Metallurgy, University of Belgrade, Serbia*
[3]*Department of Physics, Faculty of Science, University of Zagreb, Croatia*

Ferroelectric, magnetic and structural properties of $BiFe_{1-x}Nb_xO_3$ (x = 0.002, 0.005 and 0.01) ceramics were investigated in order to study the influence of B-site doping of multiferroic $BiFeO_3$. It is known that pure $BiFeO_3$ exhibits G-type of antiferromagnetism below Néel temperature (T_N = 370 °C) and spontaneous polarization along one of the eight pseudo-cubic [111] axes below Curie temperature (T_C = 826–845 °C). However, poor ferroelectric (high electrical conductivity) and weak ferromagnetism of pure $BiFeO_3$ can be enhanced by doping. In this study, Nb^{5+} was introduced to replace Fe^{3+} (B-site doping) since it could disturb the nearly antiparallel spin ordering of the adjacent Fe^{3+} ions responsible for cycloidal (spiral) spin structure. On the other hand, the pentivalent Nb cations will reduce the amount of oxygen vacancies and consequently reduce the electrical conductivity. It was shown that 1 % Nb drastically changed the magnetic properties compared with pure $BiFeO_3$: while the remnant magnetization at 300 K reaches only 0.0042 emu/g at applied magnetic fields up to 50 000 Oe, the coercive magnetic field as high as ~7460 Oe classifies $BiFe_{0.99}Nb_{0.01}O_3$ as hard magnetic material. With lower Nb content the magnetic properties moved up towards the properties of pure $BiFeO_3$. Relatively inferior ferroelectric properties showed the sample with 0.2 % Nb, since its hysteresis loops deformed at electrical fields higher than 40 kV/cm. At the highest applied electrical field (70 kV/cm) only the sample with 1 % Nb showed a stable ferroelectric response with hysteresis periods up to 1000 ms, with the highest remnant electrical polarization of 0.5 μC/cm^2 and the coercive electrical field of 22.2 kV/cm. Thus, it was shown that by carefully selected dopant it was possible to improve both magnetic and ferroelectric properties of $BiFeO_3$.