

## **BiFeO<sub>3</sub>-Based Piezoelectric Ceramics: Processing and the Effect of Electrical Conductivity on Electro-Mechanical Behavior**

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BiFeO<sub>3</sub> and its solid solutions, such as those with rare-earth (RE = Sm, Gd, Dy, Nd) ferrites, have been extensively studied in recent years as lead-free piezoelectric materials. Despite the many reports on these ceramics, we are still struggling with problems, such as the high electrical conductivity and persistent presence of secondary phases (Bi<sub>25</sub>FeO<sub>39</sub> and Bi<sub>2</sub>Fe<sub>4</sub>O<sub>9</sub>) in BiFeO<sub>3</sub>, and the inability to reproduce the electromechanical properties in RE-modified BiFeO<sub>3</sub> ceramics, as they were originally reported for epitaxial thin films (Fujino et al., Appl. Phys. Lett. 92, 202904, 2008). In this talk, we will highlight and discuss two issues of unmodified and Sm-modified BiFeO<sub>3</sub> ceramics that have raised significant controversy: processing and electrical conductivity. In particular, we will address the electrical conductivity from a different perspective, by showing how the local conductivity may affect the piezoelectric response of unmodified and Sm-modified BiFeO<sub>3</sub>.

In this presentation we will first report on the processing of BiFeO<sub>3</sub>, in particular, its high sensitivity to impurities, such as SiO<sub>2</sub>, which leads to the compositional degradation of the BiFeO<sub>3</sub> perovskite phase to the secondary phases. We will show that this problem is minimized once BiFeO<sub>3</sub> is modified with Sm<sub>2</sub>O<sub>3</sub>.

Using a combination of local electrical current measurements with atomic-force microscope (AFM) and macroscopic measurements of the electrical conductivity and piezoelectric coefficient of BiFeO<sub>3</sub>, we will link the local conductivity of domain walls with the macroscopic piezoelectric response. This behavior appears to be affected by the addition of Sm<sub>2</sub>O<sub>3</sub> to BiFeO<sub>3</sub>, which will also be discussed.

Keywords: bismuth ferrite, processing, secondary phases, piezoelectric, conductivity.

Presentation type: Invited talk