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Discovery of a universal morphotropic phase boundary behavior in rare-earth substituted $BiFeO_3$ using thin film composition spreads[1]

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Epitaxial thin film composition spreads can be used to perform systematic substitution and chemical modification studies where changes in structural and physical properties of materials can be continuously tracked. I will discuss one particular example where we study substitution of various trivalent REions into the A-site of $BiFeO_3$ (BFO) using a series of composition spreads. We had earlier reported on the transition of the rhombohedral ferroelectric structure of the undoped BFO to an orthorhombic phase in Sm-substituted BFO [S. Fujino et al., Appl.Phys.Lett. 92, 202904 (2008)]. At the structural phase boundary, electromechanical properties including the piezoelectric coefficient d_{33} and the dielectric constant are substantially enhanced. The value of d_{33} at the boundary can be as high as 110 pm/V, nearly double that of values typically reported for undoped BFO thin films. We show that there is a universal behavior with all RE dopants and that the structural transition accompanied by enhanced dielectric and piezoelectric properties can be universally described by one control parameter, the A-site average ionic radius. This work is performed in collaboration with D. Kan, L. Pálová, V. Anbusathaiah, C.-J. Cheng, S. Fujino, V. Nagarajan, and K. M. Rabe.

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