Growth, characterization and tuning of physical properties of rare-earth orthoferrite single crystals

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Abstract:

Perovskite rare-earth oxides continue to spark researchers' interest due to the formation of novel electric and magnetic phases and potential applications. Rare-earth compounds with very high melting points are best grown by the crucible-less float-zone technique. Cationic substitutions further enhance characteristic phases and fine-tune the desired properties. In powder and ceramic forms, the crystallites orient randomly in different directions and present an average effect of anisotropic properties, whereas single crystals enhance this effect in specific orientations. By ionic substitution, it compounds with additional impurity phases and structural deformations. By concomitantly applying a zone refining process to the floating zone growth, one can minimise or eliminate impurity phases to a great extent [1, 2]. The trace impurities separate due to differences in segregation coefficients and directional solidification of the pure material, which yields pure crystals that are reliable to use without fear of impurity influences.

Besides details of growth, we will report the results of standard characteristic measurements of Laue spectroscopy, XRD, and EPMA, to assess the crystallinity, orientation, phase purity and composition of few $R_{(1-x)}R_x'FeO_3$ bulk crystals. We determined the oxidation states of the substituted ions using x-ray photoelectron spectroscopy measurement to evaluate their role in physical characteristics. Partial substitution of certain selective rare earth cations in the A-site of perovskite structure has enabled tuning of many important physical properties. I will discuss, in detail, the unusual spin configurations that evolve consequentially in a few substituted phase-pure rare earth orthoferrites.

Keywords: float-zone growth, zone refining, orthoferrites, spin reorientation transitions

References:

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[2] Bhawna Mali et. al, Phys. Rev. B 105, 214417

Bio Sketch of Dr Suja Elizabeth

Dr Suja Elizabeth Saji is a research faculty in the Department of Physics at the Indian Institute of Science (IISc), Bangalore. Her expertise lies in experimental condensed matter physics that focuses on single crystalline materials. Dr Elizabeth Saji's research covers a wide range of materials, including perovskite oxides and chalcogenides, which exhibit novel phenomena such as colossal magnetoresistance, multiferroicity, magnetocaloric and magnetodielectric effects, and unconventional superconductivity. In her tenure, she established state-of-the-art experimental facilities to grow high-quality single crystalline samples of these materials. The current research interests extend to perovskites, multiferroics, metal-organic

framework compounds, and topological insulators. Her academic record includes guiding 16 research scholars to obtain their Doctoral degrees and an additional five students pursuing research under her supervision. She has co-authored 150 publications in peer-reviewed international journals and presented her research findings at numerous international conferences.

In recognition of her outstanding contributions, Dr Suja Elizabeth received the Professor S.K. Chatterjee Award for Outstanding Woman Researcher from the IISc Alumni Association in 2016 and the Professor P. Ramasamy Award for significant contributions to crystal growth. Additionally, she is an elected Executive Committee Member (2023-25) of the International Organization for Crystal Growth (IOCG).