Materials Science & Engineering Seminar Series

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Grain Growth Transitions in Perovskite Ceramics: Bimodal Microstructures, Anisotropy and Other Interfacial Properties

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ABSTRACT:
Perovskite materials are widely used in a variety of electronic devices, e.g. capacitors, oxygen conductors, PTC (positive temperature coefficient) heaters and piezoelectric actuators. Many macroscopic properties of polycrystalline perovskites are governed by their grain boundaries and, therefore, depend strongly on microstructure evolution (sintering and grain growth) during processing.
Several perovskite ceramics (ABO_3) are known to show a non-Arrhenius type of grain growth. Strontium titanate has a grain growth rate transition that has been well documented, with decreasing growth rates between 1350°C and 1425°C. Other materials such as barium titanate, lithium lanthanum titanate and barium strontium titanate show similar grain growth rate transitions. The growth transitions are coupled to the formation of bimodal microstructures and are postulated to be caused by grain boundary structural transitions.
This talk reviews our current understanding of the grain growth rate transitions in perovskite ceramics. A simple mean field approach is often used for quantifying these effects on a macroscopic scale. However, this approach fails to capture the underlying physics of bimodal anisotropic grain growth that occurs in ceramic perovskites. Important factors including anisotropy, atomistic boundary structure, segregation, wetting, faceting, boundary stoichiometry, space charge and interfacial drag need to be considered explicitly. A discussion of open questions and future directions will be presented.

BIOGRAPHY:
Dr. Rheinheimer received his doctorate from Karlsruhe Institute of Technology (KIT) in 2013, studying the Interfacial Energy and Grain Growth Anisotropy of $SrTiO_3$. He was a postdoctoral researcher at KIT in the Institute of Applied Materials (IAM), Ceramics in Mechanical Engineering under Prof. Dr. Michael J. Hoffmann from 2013 to 2014 where he conducted research on:

- Electromechanical characterization of ferroelectric actuators (PZT)
- Sintering of PZT multilayer actuators with control of PbO evaporation and its correlation to electromechanical performance
- Flash sintering of PZT multilayer actuators
- Diffraction contrast tomography on 4D grain growth in perovskite ceramics

In 2015 he was appointed as a Group Leader in the IAM at KIT, where his current research interests are:

- Fundamentals of grain growth of perovskite ceramics
- Interfacial properties: Anisotropy, mobility, wetting and structure and their impacts on properties
- Synthesis and sintering of perovskite ceramics (STO, BTO, BST, KNN, LLTO, BNT-BT)
- Sintering and grain growth under the influence of electrical field
- Impact of defect chemical parameters on materials processing and properties

Modelling of microstructure evolution

Doherty Hall 2210, 11:30AM
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