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Seminar

Thomas Defferriere

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Wednesday, 18th September, 09:00 s.t.
TU Wien, Getreidmarkt Campus
Building BC, Ground Floor, Seminar Room BC EG

The seminar will also be held as a Zoom Meeting
https://tuwien.zoom.us/j/67534182473?pwd=1pmgakL4N2Wa7yK9KKkKsRF9x7Rqo9.1
Meeting ID: 675 3418 2473
Password: Hf9Bvme0

Grain Boundary Space Charge Engineering in Ceramic Ionic Conductors and Its Role in Novel Radiation Detection Concepts

Grain boundaries in polycrystalline materials have long been reported to have a dramatic impact on the electrical behavior of semiconductors. In ion-conducting ceramics, used for batteries, fuel cells, and electrolyzers, these interfaces often contribute to increased ohmic losses and can lead to long-term performance degradation, which are seen as detrimental. The modified transport characteristics across grain boundaries are often attributed to space-charge potential barriers, characterized by depletion zones and band bending due to trapped core charges.

Inspired by the recognition from the semiconductor field that photogenerated charge carriers can reduce band bending at interfaces, we demonstrated how above band gap illumination could be used to modulate these space charge effects in a model polycrystalline oxygen solid electrolyte thin film (Gd-doped CeO_2)[1]. We observed that this optoionic effect, first established in thin films, could be replicated in bulk ceramics (~mm thick), using deeply penetrating gamma rays, achieving reversible resistance modulations of ~10^3 near room temperature[2]. This discovery opens the door to a novel class of radiation detection devices that leverage the modulation of ionic currents at grain boundaries in solid electrolytes, rather than the traditional collection of photogenerated charge carriers in single-crystal semiconductors. These devices promise to be inexpensive, low-power, and miniaturizable, with the capability to operate in harsh environments.

I will discuss the potential advantages of this new device concept over conventional semiconductors for radiation detection and outline our approaches to engineering high-performance. Central to this is the grain boundary space charge engineering strategy that we have employed, allowing us to substantially enhance the radiation sensitivity of the otherwise insulating ceramics. To our knowledge, this represents the first systematic demonstration of space charge engineering at grain boundaries in ion-conducting solid electrolytes, with broad implications not only for radiation detection but also for the understanding of space charge physics in electrochemical cells.

All interested colleagues are welcome to this seminar lecture
(45 min. presentation followed by discussion).

Günther Rupprechter
Director of Research

André Vogel
Coordinator

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[1] T. Defferriere, D. Klotz, J. C. Gonzalez-Rosillo, J. L. M. Rupp, and H. L. Tuller, *Photo-Enhanced Ionic Conductivity Across Grain Boundaries in Polycrystalline Ceramics*, Nat. Mater. 21, 438-444 (2022) https://doi.org/10.1038/s41563-021-01181-2

[2] T. Defferriere, A. S. H. A. Elwakeil, J. Rupp, J. Li and H. L. Tuller, *Ionic Conduction Based Polycrystalline Oxide Gamma Ray Detection - Radiation-Ionic Effects.* Adv. Mater., 2309253 (2024). https://doi.org/10.1002/adma.202309253