

## Vortragsankündigung

**Mittwoch, 29. Oktober 2025, 11.15 Uhr im SR I**

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### **“Thermo-iono-electronic (TIE) materials: Unified perspectives of thermoelectrics and ceramic gas-transporting membranes and recent performance improvements through texturing”**

In addition to ionic and/or electric charge carriers, it is proposed to consider entropy as further basic quantity being transported through a thermo-ionic-electronic (TIE) material. Conversion of energy is easily understood as the loading of energy from entropy current (thermal energy) to ionic current or electronic current (both electrochemical energy). Analogies between the Soret coefficient, the Seebeck coefficient and the ionic transfer number become evident. The latter plays an important role in the context of the mixed ionic-electronic conductor (MIEC), which can be considered as TIE under isothermal conditions. If the TIE is simultaneously placed in gradients of temperature and electrochemical potential (ionic and/or electronic), currents of entropy, ionic charge carriers, and electronic charge carriers are observed (i.e. Soret diffusion or thermoelectrics). In the basic transport equation, the TIE material appears as tensor, which is a major advantage over the concept of the so-called thermodynamics of irreversible processes. The role of energy and its conversion is easily understood by the flux of entropy, ionic charge carriers, and electronic charge carriers at their respective local potentials, which are the temperature, the ionic electrochemical potential, and the electronic electrochemical potential.

An overview of the activities of our group in the context of the subsets of TIE materials, thermoelectric (TE) materials and MIEC for oxygen-transporting membranes (OTMs) is given with some emphasize on the utilization of anisotropic transport properties in layered oxide systems (e.g. “ $\text{Ca}_3\text{Co}_4\text{O}_9$ ” =  $[\text{Ca}_2\text{CoO}_{3-\delta}]_{0.62}\text{CoO}_2$ ,  $\text{La}_2\text{NiO}_{4+\delta}$ , and  $\text{Nd}_2\text{NiO}_{4+\delta}$ ) in (nano)structured bulk ceramics with texture. Together with our cooperation partners, we have applied a variety of techniques for ceramic texturing, including electrospinning of nanofibers and nanoribbons, spark plasma sintering (SPS), spark plasma texturing (SPT), magnetic grain alignment, and crystal facet engineering via reverse microemulsion synthesis. Substantial performance improvements were realized.