1st session of Focus Materialchemie – Wednesday, **30.03.2022** 16:00 - join us on ZOOM (ID: 939 5831 5298)

Cataluminescence in perovskites: a novel energy conversion

Andreas Borgschulte,[1,2]

[1]*Laboratory for Advanced Analytical Technologies, Empa - Swiss Federal Laboratories for Material Science and Technology, Überlandstrasse 129, CH-8600 Dübendorf, Switzerland*

[2]*Department of Chemistry, University of Zurich, Winterthurerstrasse 190, CH-8057, Zürich, Switzerland*

In my talk, I will shortly review various ideas of a future circular energy scenario. Although much R&D is focused on the production of renewable energy carriers, their conversion into heat, work, and electricity on demand is equally important. However, apart from hydrogen, the conversion efficiency of most renewable energy carriers such as hydrocarbons, and ammonia is limited. Thermophotovoltaic energy conversion devices are a relatively old idea, which did not make it due to the low conversion efficiency. I will sketch the functioning of such devices, from which one can conclude that the efficiency is very low due to the low efficiency of chemical energy to light limited by the process of heat from the chemical reaction released as black body radiation [1]. From a fundamental point of view, the direct conversion of chemical energy into light without the detour is possible in principle. For the first time, we demonstrate this so-called cataluminescence [2] from methanol combustion over Er-substituted $SrTiO_3$ with high efficiency. The catalytically active quaternary perovskites $Er_xSr_{1-x}Ti_{0.95}Cu_{0.05}O_{3-d}$ are non-conducting in oxidized state, but exsolute metallic Cu particles onto the surface upon reduction at high temperatures [3]. Thus, we are able to manipulate the metallic state and investigate its influence on the catalytic as well as luminescent properties. Coincidentally, the fuel to air ratio ('lambda ratio') around the stoichiometry point corresponds to the tipping point between reducing and oxidizing conditions altering the surface properties as evidenced by operando optical spectroscopy and post mortem X-ray diffraction and X-ray photoemission. Cataluminescence takes place under oxidizing conditions (lean fuel to air mixture) on the Er-perovskite with a strong selective IR- emission, while under reducing conditions Cu-nanoparticles develop, which emit black body radiation [4].

[1] T.J. Coutts, A review of progress in thermophotovoltaic generation of electricity, Renew. Sustain. Energy Rev. 3 (1999) 77–184.

[2] M. Aras, V., M. Breysse, B. Claudel, L. Faure, M. Guenin, Chemiluminescence during Catalysis - Part 2, J. Chem. Soc., Faraday Trans. 1 (1977) 1039–1047

[3] Ohhun Kwon, Sangwook Joo, Sihyuk Choi, Sivaprakash Sengodan, and Guntae Kim, Review on exsolution and its driving forces in perovskites, J. Phys. Energy 2 032001 (2020).

[4] A. Borgschulte, O. Sambalova, E. Billeter, A. Sterzi, J. Niggli, B. Welte, A. Heel, R. Holzner, Cataluminescence in Er-Substituted Perovskites, Advanced Science 8 (19), 2101764 (2021).