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Evaluation of oxygen delivery from nanoporous perovskite solid solutions with in situ XRD and TG-MS

Perovskite solid solutions are versatile materials, which are widely used especially in heterogeneous catalysis [1]. Their performance is determined by the materials‘defect chemistry, charge charrier transport properties and surface area. Hence, nanoporous perovskites, due to their large surface and thus higher reactive area, are well suited for the use in Solid Oxide Fuel Cells (SOFC), solar-to-fuel processes, the oxidation of n-alkanes and the soot combustion in diesel exhaust gases. All these applications need oxygen as reactive species, so they are all strongly influenced by the oxygen release and transport property of a catalyst or substrate material [1-4].
In order to be able to tailor the perovskites for the above applications, we wanted to understand the influence of the porosity and surface area on oxygen delivery and transport in nanoporous perovskite solid solutions of cubic SrTiO3 with lanthanum and manganese which partly replaced strontium and titanium, respectively (space group $Pm3m$). Samples were prepared using a modified Pechini synthesis with surface areas ranging from 5 m^2/g to 150 m^2/g [5]. Structural and morphological characterization of the samples were carried out via x-ray diffraction (XRD), electron microscopy and nitrogen physisorption. Oxygen delivery was quantified via thermogravimetric (TG) measurements coupled with mass spectrometry (MS) as well as in situ high temperature synchrotron radiation x-ray diffraction with temperatures up to 1223 K. Subsequent Rietveld refinement was used to determine the site occupation of oxygen at varying temperatures.
The highest oxygen release rates were found in the perovskite sample with higher porosity. All TG measurement showed three gradients at different temperatures during heating under low oxygen partial pressure, which we contribute to different oxygen species that where released from different sites of the perovskite lattice [6]. The measurements from the in situ x-ray diffraction supported the results from the TG-MS experiments well.

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Primary author: EHRHARDT, Benedikt (Department of Chemistry, University of Hamburg)

Co-authors: MASCOTTO, Simone (University of Hamburg); Dr GIGLI, Lara (Elettra-Sincrotrone Trieste S.C.p.A.,); MEYER, Nils-Felix (Department of Chemistry, University of Hamburg)

Presenter: EHRHARDT, Benedikt (Department of Chemistry, University of Hamburg)

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