CHARACTERIZATION OF NOVEL DOPED PEROVSKITE CATALYSTS – TAILORED EXSOLUTION OF METAL NANOPARTICLES

Lorenz Lindenthal[a], Janko Popovic[a], Johannes Raschhofer[a], Thomas Ruh[a], Raffael Rameshan[a], Andreas Nenning[b], Alexander K. Opitz[b], Christoph Rameshan[a]

[a]E165 - Institute of Materials Chemistry
[b]E164 - Institute of Chemical Technologies and Analytics

INTRODUCTION

Perovskite-type oxides are a large class of materials with many interesting properties, including piezo- and pyroelectricity, mixed ionic-electronic conductivity and high catalytic activity. Thus, there is a wide range of applications, for example the use as sensors or as electrode materials in solid oxide fuel cells. Their general chemical formula is ABO3, with two different cations A (bigger) and B (smaller). The ideal structure is cubic, but it is often distorted as can be seen for La0.9Ca0.1FeO3 (figure 1). The high versatility of the material class is due to the possibility of adjusting the properties by choosing different elements for the cations. Doping either one or both of the cation sites opens up an even larger matrix for materials design.

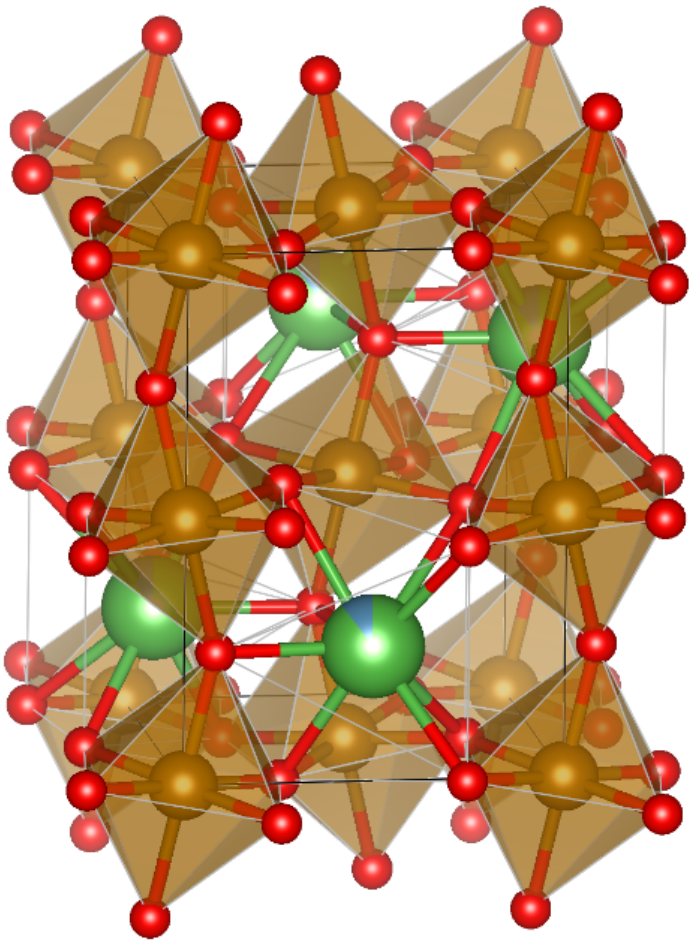

Figure 1: Distorted perovskite structure of $La_{0.9}Ca_{0.1}FeO_3$, data from XRD measurement (La/Ca-green/blue, Fe-brown, O-red).

In terms of catalysis, another recently shown outstanding property of perovskites is the exsolution of metal nanoparticles under reducing conditions. This surface modification (by migration of cations to the surface) can change the catalytic activity and selectivity of the perovskite surface completely and is the core topic of our ERC project.

RESULTS AND DISCUSSION

Several perovskite-type oxides (e.g. LaxCa1-xFeO3 or NdxCa1-xFeO3), that are promising catalyst materials, have been synthesised and subsequently characterised. These perovskites are promising catalyst materials for several energy related reactions, such as the (reverse) water gas shift reaction. Using different reducing conditions, the stability and reducibility of the synthesized perovskites were investigated in-situ. X-ray diffraction (XRD) allowed structural determination, while X-ray photoelectron spectroscopy (XPS) gave additional chemical information on the surface state. These characterisations have been complement by additional analytical methods. It was possible to show the reversible exsolution of metal nanoparticles in an ideal metastable window.

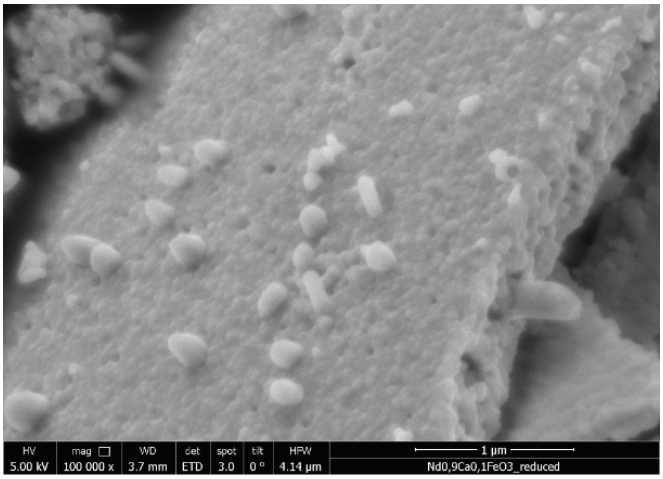

Figure 2: SEM picture of exsoluted nanoparticles on $Nd_{0.9}Ca_{0.1}FeO_3$.

ACKNOWLEDGEMENT

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement n° 755744 / ERC - Starting Grant TUCAS)