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In-Situ Studies of Tailored Nanoparticle Exsolution on Catalyst Surfaces
Driven by Electrochemical Potential, Gas Composition and Gas Pressure

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In heterogeneous catalysis, excellent performance can be achieved by uniformly dispersed, ideally catalytically highly active (nano)particles on a surface. Our aim is to tailor and control the formation of nanoparticles on a surface during reaction by either applying an electrochemical potential (bias) and/or adjusting the gas phase (pO_2).

We use Perovskite-type oxide catalysts for our research, as they can incorporate catalytically highly active guest elements as dopants. When reducing conditions (electrical bias or pO_2) are applied, the dopants are exsolved from the oxide lattice and form catalytically active and morphologically stable nanoparticles on the surface, thus cause increasing the catalytical activity of the material.

Whether the process of exsolution can be characterized by one parameter independent of the driving force – for instance electrochemical polarization (bias) or gas phase composition (pO_2) – remains an open question. Different surface structures dependent on the driving force will be explored.

We thoroughly characterised $Nd_{0.6}Ca_{0.4}Fe_{0.9}Co_{0.1}O_{3-\delta}$ using different methods: In-situ Near Ambient Pressure X-ray Photoelectron Spectroscopy (NAP-XPS) studies are supported by Electrochemical Impedance Spectroscopy (EIS) and Scanning Electron Microscopy (SEM). Furthermore, “high pressure” (160 mbar) measurements performed at a synchrotron (DESY) were used to further explore the questions about exsolution driving forces. Especially the switching behaviour of iron to iron oxide as well as cobalt to cobalt oxide at different electrochemical, gas phase and pressure conditions was compared.

How these conditions affect the particle size and distribution was investigated by SEM. We could show that the exsolution behaviour of these (nano)particles can be described by only using a calculated pO_2 value (derived from combining bias and gas phase); however, the size of the obtained (nano)particles differs depending on how exsolution was triggered (by bias or gas phase). Moreover, we present our first attempt of investigating the pressure dependence of exsolution.

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if “Other”, please specify:

I apply for a travel grant

Yes

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