We produce **alloyed nanoparticles** by reducing **doped perovskites**.

Tailoring bi- and trimetallic nanoparticles by exsolution from perovskites

L. Lindenthal[1], H. Drexler[1], J. Rollenitz[1], F. Schrenk[1], T. Berger[1], R. Rameshan[1], T. Rocha[2], T. Mori[2], L. Borges[2] and C. Rameshan[1]

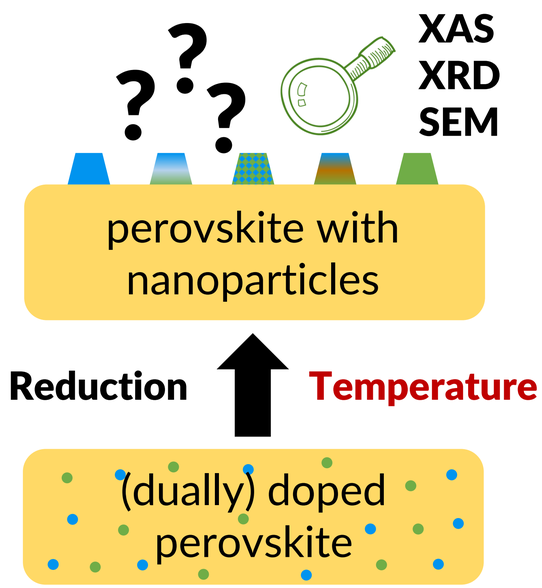
[1]Montanuniversität Leoben, Chair of Physical Chemistry, 8700 Leoben, Austria

[2]Center for Research in Energy and Materials (CNPEM), LNLS, 13083-100, Campinas, São Paulo, Brazil

Introduction

Reducing a doped perovskite oxide can trigger **exsolution**, when the dopants emerge on the surface forming metal **nanoparticles**. In the case of multiple doping, this process is rather complex, various behaviors and thus resulting particle compositions are conceivable.

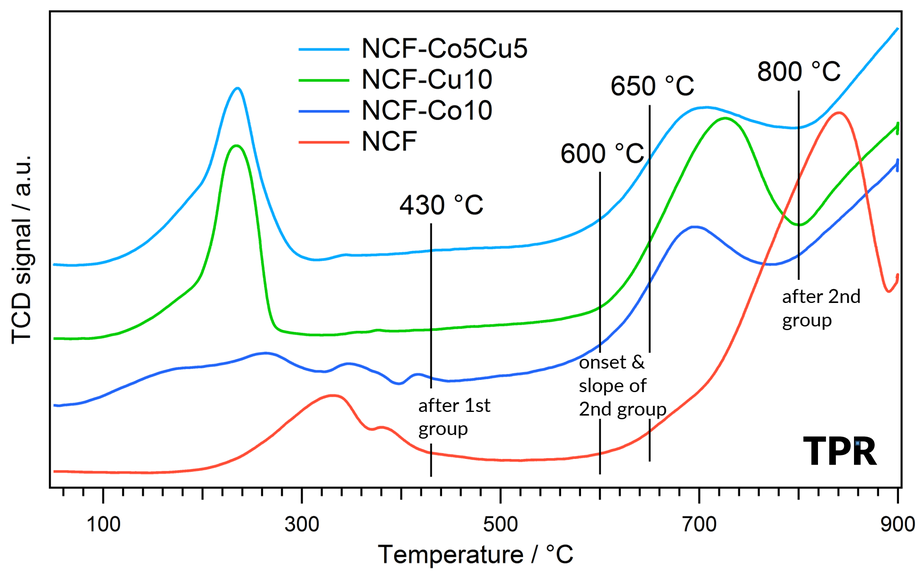
Focusing on the critical parameter of the **temperature** during reduction, this study investigates several doped variants of the perovskite **$Nd_{0.6}Ca_{0.4}FeO_{3-\delta}$ (NCF)**, in order to understand the system dually doped with **Co and Cu**.



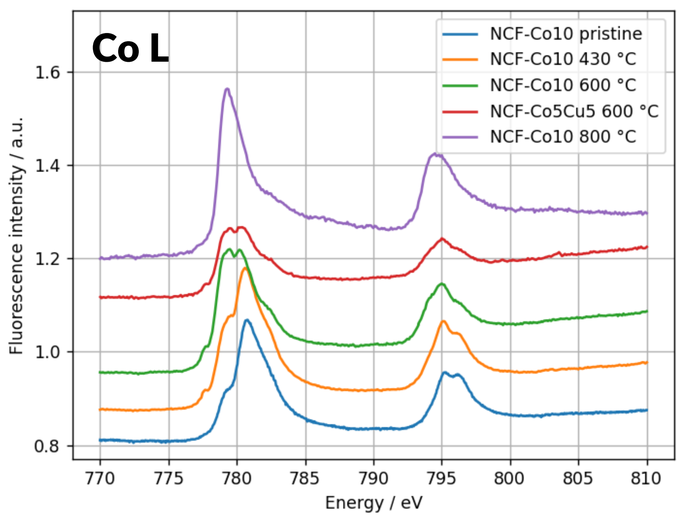
10 % Co: NCF-Co10
10 % Cu: NCF-Cu10
5 % Co + 5 % Cu: NCF-Co5Cu5

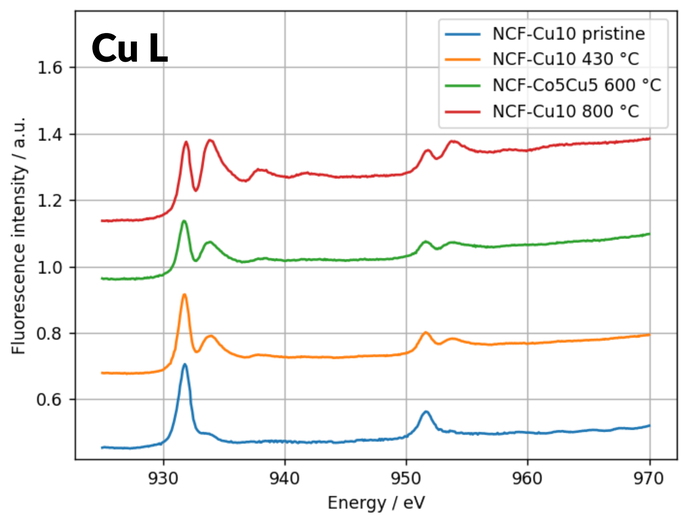
Approach

The materials have been reduced in 5 % H_2 at different temperatures, which were chosen according to interesting points in the profiles of **temperature programmed reduction (TPR)** experiments. Afterwards, they were investigated using **X-ray diffraction (XRD)**, **X-ray absorption (XAS)**, and **Scanning Electron Microscopy (SEM)**.



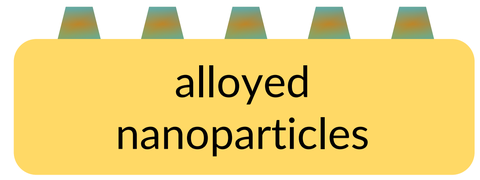
Results XAS





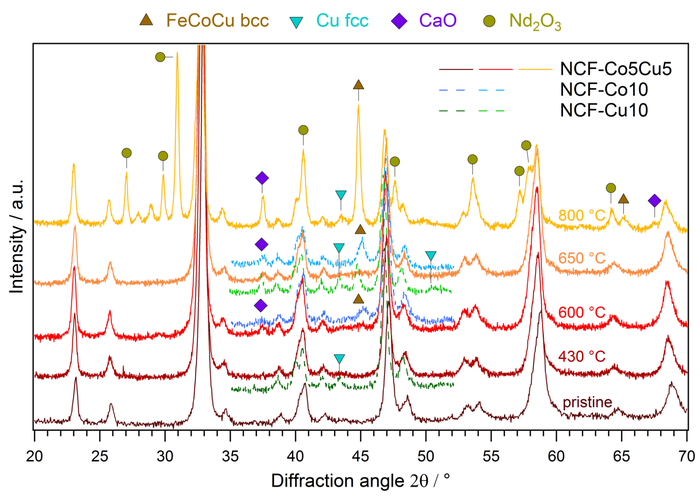
Comparison of the spectra shows both metallic Co and Cu species above 600 °C in NCF-Co5Cu5.

Conclusion



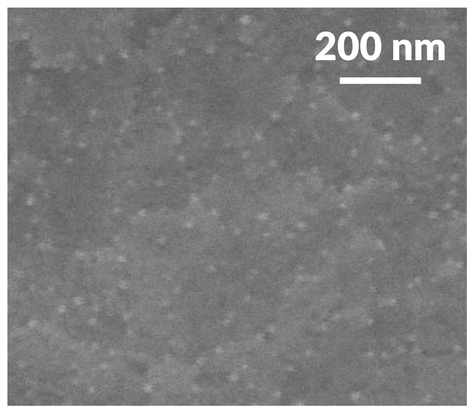
- Exsolution starts at ~**600 °C**.
- The particles are **alloyed**, consisting of both Co and Cu, as well as the host element Fe, resulting in a metallic **bcc phase**.
- These particles are **needle-like** with length **~40 nm**.
- Above ~700 °C, the material **decomposes**.

Results XRD

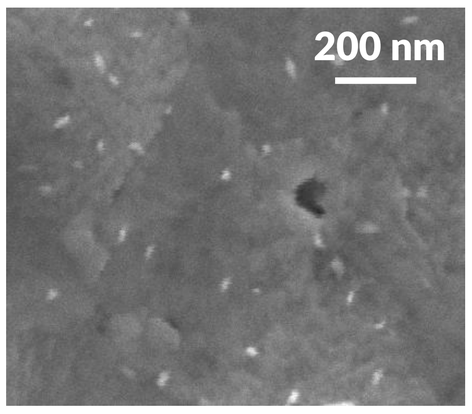


In NCF-Co5Cu5, only a metallic bcc phase is seen.

Results SEM



NCF-Co10 after 600 °C: spheres, size ~30 nm.



NCF-Co5Cu5 after 600 °C: needle-like, length ~40 nm.

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

Take a picture to find out how **exsolution** can be used for **catalysis**.