Spinels in the Cu-Mn-(Fe, Ni, Zn, Cr)-O system: synthesis, studies of structure, physicochemical properties, and *operando* electrocatalytic activity

Spinels are a material group which owes a name to the magnesium/aluminum mineral with the chemical formula $MgAl_2O_4$. The name comes from the Latin word *spinella*, little thorn, referring to its pointed crystals. The spinels are transition metal oxides with the general formula AB_2O_4 (where A and B are transition metal ions) exhibiting physicochemical properties that can be tuned dependent on their chemical composition. Spinels are found in a variety of colors, including red, blue, violet, green, brown and black. From a scientific point of view, spinels show distinctive optical, electrical, magnetic, and catalytic properties. These materials can possibly replace expensive electrocatalysts allowing for a transition to renewable energy systems.

Nowadays people are getting more and more aware of the global warming crisis, and scientists all over the world are looking for methods to change this matter of fact. The energy production based on fossil fuels has a devastating impact on the environment, and new energy sources are required. One of the most promising ideas is the production of hydrogen fuel via water electrolysis. To make it more cost-efficient there is a need to apply materials facilitating the electrochemical water splitting process, namely electrocatalysts.

The goal of this project is to establish a synthetic route for pure single-phase polycrystalline manganese-copper spinels modified by doping with additional elements (iron, zinc, nickel, chromium). Those materials will be evaluated in the terms of activity towards oxygen evolution reaction, the reaction which is the part inhibiting the overall performance of water electrolysis, hence the profitable hydrogen production. To check the influence of dopants on the spinel properties we will use highly sophisticated techniques, for example, Scanning Electron Microscopy (SEM), X-Ray Photoelectron Spectroscopy, and X-Ray Absorption Spectroscopy.

This project's aim is to determine the active sites during electrocatalysis by *in situ* combination of spectroscopic methods with electrochemical studies and give a deeper understanding of the ongoing reaction mechanism. We believe that this project will significantly contribute to the search of materials for sustainable energy systems.