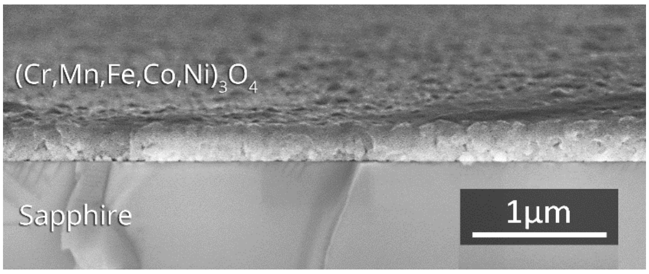
Nanocrystalline High-Entropy Spinel Oxide Films: The Influence of Electron Configuration and Crystallographic Position of Cations on Physicochemical Properties

The idea of high-entropy stabilized materials was born in 1995 through elaboration concept of high entropy alloys (HEA). Definition state the existence of multi-component alloys with 5 up to 13 elements with a concentration between 5 and 35 at% and certainly shows the essence of the whole concept of high-entropy materials. A new approach to multi-component oxides started in 2015 when Rost et. al published the ground breaking work entitled "Entropy-stabilized oxides". Thereafter high-entropy oxides have attracted the interest of the scientific community due to their exceptional structural features opening great possibilities for tailoring of functional properties, e.g. for oxygen reduction/evolution reactions. Proper selection of cations determines the unusual physicochemical properties such as superionic conductivity at room temperature, colossal dielectric constant or reversible lithium storage properties. High-entropy spinel oxides are multicomponent materials with a general composition of $(A_1,A_2,A_3,A_4,A_5...)_3O_4$, based on five or more equimolar mixture of cations occupying the same crystallographic position. Due to the presence of multiple elements, there are plentiful opportunities to explore and to characterize structural, microstructural, electronic and catalytic properties of new compositions crystallizing in spinel-based crystal structures.



The main goal of the project is to deposit single-phase spinel-based high-quality thin films of multi-cation materials, explore their structural and electrical properties and determine the influence of cation composition and film microstructure on its functional properties. So far these oxides were studied purely in the form of bulk materials. The novelty of the research is a detailed study of new entropy stabilized oxide materials prepared in a form of thin layers (<300 nm). The main part of the project will be an attempt to describe the mechanisms of electrical conductivity and electrocatalytic activity occurring on the surface of nanocrystalline high entropy spinel oxide thin films.

The project will bring new knowledge about the high entropy oxides gained through studies performed on new compositions and on thin films. By designing of the spinels according to their specific atom arrangement, and their subsequent studies, much deeper understanding of the role of cation sites will be gained. This project can give a deeper insight into the fundamental nature of the physicochemical properties of this new group of oxides. Without a doubt, these investigations contribute to advances in entropy ordered materials design and our understanding of the materials science.