

## Development of synchrotron operando measurement methods for high-temperature electrochemical processes: case study of solid oxide cell oxygen electrode.

Operando measurements are a special group of measurements that allow for the structural analysis of a material during an electrochemical reaction. Thanks to these measurements, it is possible to determine the active center of the material, explain the mechanisms responsible for the catalytic reaction and comprehensively describe the structural and electronic changes occurring in the material in working conditions. Obtaining such information is crucial in understanding the mechanism of the electrochemical reaction, determining limiting factors and explaining material degradation. The information obtained can be used in further studies to improve or search for new materials.

Human impact on the environment is currently one of the most important issues in Europe and the world. Public awareness of this issue is growing, and scientists are trying to find solutions to replace conventional energy sources with renewable sources. One of the promising concepts for the "fuel of the future" may be hydrogen, especially its green version, obtained from electrolysis powered by renewable energy sources. Hydrogen can be used as a fuel in solid oxide cell technology, which operates at high temperatures (>600 °C) and provides a stable source of electricity for years.

The aim of the project is to obtain a tool enabling structural analysis using X-ray Absorption Spectroscopy (XAFS) combined with measurements of catalytic activity using Electrochemical Impedance Spectroscopy (EIS). Selected materials will be analyzed for changes occurring during the electrochemical reaction of oxygen reduction to  $O^{2-}$  anions. The project assumptions will enable the connection of data obtained from EIS with structural data, which will be used to describe the mechanism of the electrochemical reaction and the structural changes of the material resulting from its catalytic properties. This data will allow for precise determination of limiting mechanisms and identification of key factors that need to be solved. In the longer term, solving them by obtaining more efficient materials used as oxygen electrodes.

We believe that the project will significantly contribute to the development of high-temperature solid-state electrochemistry and operando techniques in the context of measurements performed at the synchrotron. Ultimately, the aim of the project is to provide a solution that performs measurements in real time, enabling measurements in various atmospheres and performing various types of electrochemical characteristics.

