3D Contact Angle Measurements and Image Analysis in Solid-Oxide Cell Materials

Type: Semester project (Bachelor or Master)
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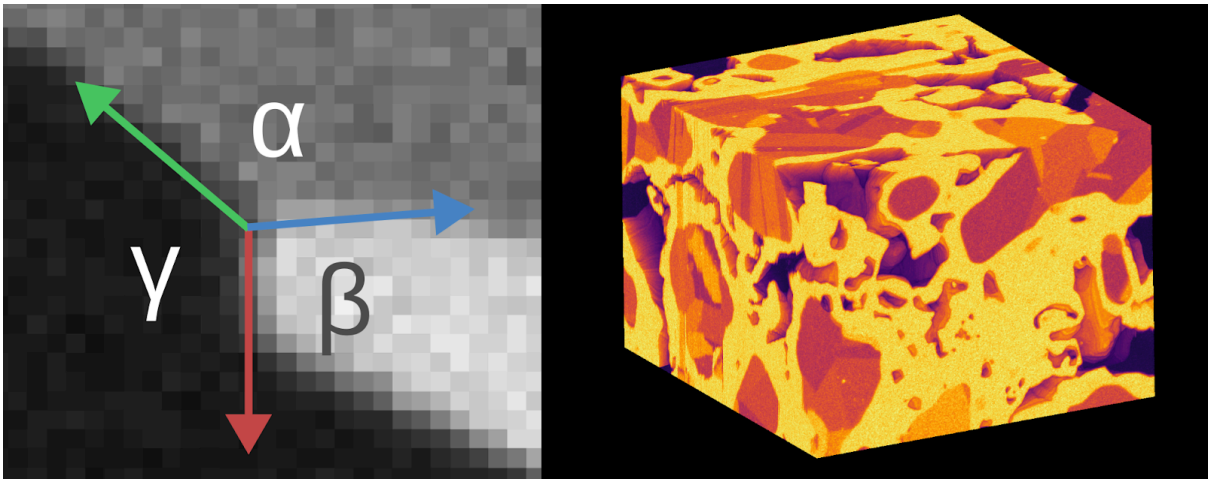

Solid Oxide Cells (SOC) contribute to the energy transition due to their high efficiency, large fuel flexibility and reversibility between fuel cell and electrolysis operations. The SOC microstructure directly affects performance and durability, making the microstructural analysis an essential part in SOC research.
The SOC is composed of three phases: wetting, non-wetting and solid. A highly efficient SOC is characterized by low phase tortuosity, high percolation and high triple phase boundary (TPB) density. During operation, the SOC microstructure evolves, and several imaging techniques can be used to observe this evolution.

Advanced 3D electron microscopy techniques like Focused Ion Beam Scanning Electron Microscopy (FIB-SEM) provide rich datasets for studying these materials, but processing and analyzing these datasets require specialized tools and methodologies.

This student project will involve working with 3D FIB-SEM datasets to advance the analysis of SOC materials. The first task will focus on preprocessing the datasets, including denoising and aligning the image stacks along the Z-axis using image registration techniques (for example, pystackreg). Next, the student will develop a method to segment multiple phases in the data using semi-automated approaches (for example, Ilastik). The final stage of the project will involve developing an algorithm for measuring contact angles at the interfaces between the phases. If successful, the work can be integrated into a Python package, creating a valuable resource for the materials science community.

By the end of this project, the student will contribute to the development of advanced tools for analyzing SOC materials. This project is ideal for students interested in materials science, image processing, data science, and algorithm development, with experience in Python programming.