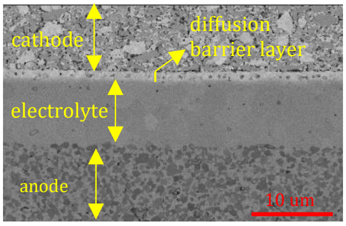
Development of diffusion barrier layer using magnetron sputtering

(preferably for students with a background or interest in material science)
Contact: Samaneh Daviran, Samaneh.daviran@epfl.ch

Solid Oxide Cells (SOCs) are composed of different materials for the anode, cathode, electrolyte, and interconnects. For example, the electrolyte is often made of yttria-stabilized zirconia (YSZ), the anode is composed of nickel-YSZ (Ni-YSZ), and the cathode of lanthanum strontium manganite (LSM), as shown in Figure 1a. At the high operating temperatures of SOCs, interdiffusion between adjacent layers can lead to the formation of secondary phases, which degrade the electrochemical performance. Diffusion barrier layers are used to prevent or minimize such interdiffusion between the electrolyte and cathode. Such interlayers must still allow for the efficient transport of oxygen ions while blocking undesirable interdiffusion of cations.

a)



b)

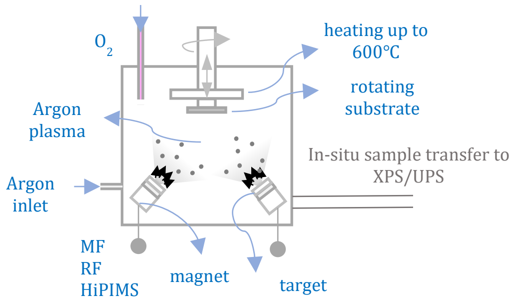


Figure 1. a) Cross-section view of a SOC, showing diffusion barrier layer,
b) Schematic of reactive magnetron co-sputtering

Magnetron sputtering is an advanced thin-film deposition technique that enables the development of uniform, high-density layers, making it ideal for diffusion barrier layer. In magnetron sputtering, a vacuum chamber is used to create plasma by applying a current to a target material; inert or reactive gases (such as argon, oxygen, or nitrogen) are introduced to facilitate the process. Atoms ejected from the target material are then deposited onto the substrate, growing a thin film. The schematic of the sputtering configuration is shown in Figure 1b. The efficiency and properties of the developed coating are highly dependent on factors such as film density, grain morphology, and microstructure, all of which can be controlled and optimized through deposition parameters, such as gas flow rate, chamber pressure, applied current, and substrate temperature. By adjusting these parameters, the microstructure of the film can be tailored to meet the specific requirements of the protective coating.

This project aims to develop a thin and dense diffusion barrier layer for SOCs using magnetron sputtering. Surface characterizations such as SEM/EDX, XRD, and XPS will then be performed on the developed thin films. The project will begin with a literature review on diffusion barrier layers and the possible formation of secondary phases resulting from interactions with such layers. The student will receive supervision throughout all steps, including material selection. Training on the magnetron sputtering machine will be provided in the laboratory at the Lausanne campus. The student will also be responsible for analyzing and interpreting the characterization results.