Solid Oxide Fuel Cells: From Fundamentals to Thin Film Model Electrodes

Jürgen Fleig, Alexander K. Opitz, Markus Kubicek, Andreas Nenning, Tobias Huber, Andreas Limbeck, and Herbert Hutter

Institute of Chemical Technologies and Analytics, Vienna University of Technology, Vienna, Austria

*j.fleig@tuwien.ac.at

Fuel cells are energy conversion systems avoiding the thermodynamic efficiency limitations of conventional power generation. Instead of relying on the heat production of a conventional chemical reaction, fuel cells transfer chemical energy directly to electrical energy by an electrochemical reaction. Several types of fuel cells are in the process of entering large-scale production and solid oxide fuel cells (SOFCs) are among the most promising and successful ones. SOFCs operate at temperatures of 600 to 1000°C and are based on an oxide as oxygen ion conducting electrolyte. Despite impressive efficiencies of up to 60%, theoretical limits are by far not reached yet and long-time stability as well as costs retard commercialization. Intensive scientific efforts to understand reasons behind efficiency limitation and degradation are under way.

In this contribution, first some basic aspects of SOFCs and their applications will be introduced. In a second step, it will be shown how research activities on pulsed laser deposited (PLD) thin film electrodes lead to a better understanding of the electrochemical processes in SOFCs and thus the reasons behind efficiency and stability limitations. Among others, secondary ion mass spectrometry (SIMS) was employed for measuring oxygen tracer ($^{18}$O) distributions in electrodes and electrolytes and could identify active and resistive zones of electrochemical electrode reactions.