INDO SWISS JOINT RESEARCH PROGRAMME (ISJRP)

JOINT RESEARCH PROJECT

ABSTRACT

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ELECTRONIC ORIGIN OF CR POISONING IN CERAMIC FUEL CELL CATHODES

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PROJECT ABSTRACT

This Indo-Swiss research project aims at elucidating the origin and influence of chromium doping and substitution on the structure and transport properties in rare-earth transition metal oxide perovskites (LaSrMn-oxide and LaSrFeCo-oxide), and identification of the driving forces of metal-insulator like transitions therein. This study is relevant for the ageing of ceramic fuel cell cathodes. The work will be carried out at EMPA Dübendorf, Laboratory for High Performance Ceramics, and India Institute of Science Bangalore, Solid State and Structural Chemistry Group, and Centre for Condensed Matter Theory.

Modern synchrotron based photoelectron and x-ray spectroscopy methods are employed together with transport measurements in order to address the chromium poisoning in ceramic fuel cell (SOFC; solid oxide fuel cell) cathodes. Chromium poisoning is one of the malign degradation processes in SOFC, which over operation time leads to performance loss of the SOFC.

Ceramic fuel cells, typically referred to as solid oxide fuel cells (SOFC), are based on ceramic components, i.e. ceramic anodes, electrolytes, and cathodes, and metallic interconnectors which have the role of mechanical support and current collectors. The cathodes are perovskites such as the mixed electronic-ionic conducting LaSrMn-oxide or the electronic conducting LaSrFeCo-oxide. The electrolytes are typically the ion conducting cerium-gadolinium oxide (CGO) or yttrium-stabilized zirconium oxide (YSZ), and evolve their conductivity not below temperatures of 600°C. Operation temperatures up to 950°C are not un-common. This high temperature makes that the interconnectors, which are typically chromium based steels, evaporate the chromium to some extent, which then reacts with the cathode to form poorly conducting spinel structures, and poorly conducting Cr_2O_3 films at the interconnect surface.

The aforementioned processes are not exactly known in every detail, particularly since understanding at the molecular level is virtually missing. However, the insight coming from improved understanding

of the molecular mechanisms of chromium poisoning should guide us to find educated routes for abatement of chromium poisoning, such as using protective coatings or more tolerant cathode materials, for example.

A significant challenge as well as novelty is our combination of concepts traditionally used in solid state physics at low and ambient temperatures (strongly correlated fermion systems), and solid state electrochemistry at elevated temperatures (solid state ionics), notwithstanding that the conductivity originates not only from electronic but also from ionic processes. Latter will be taken care of by defect chemistry calculations, the parameters of which are provided by the experimental work of this project.