Oxygen surface exchange kinetics of mixed ionic-electronic conducting oxides

Henny J.M. Bouwmeester

Electrochemistry Research group, Membrane Science and Technology, Department of Science and Technology, MESA+ Institute for Nanotechnology, University of Twente, P.O. Box 217, 7500 AE, Enschede, The Netherlands

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h.j.m.bouwmeester@utwente.nl

Abstract

High-temperature electrochemical devices such as solid oxide fuel cells, solid oxide electrolysis cells, oxygen separation membranes and membrane reactors based upon fast oxygen ionic conducting oxides have the potential to provide great economic and ecological benefits. One of the challenges of researchers in this field is to develop materials showing fast oxygen ionic transport *and* fast surface exchange kinetics under given operating conditions. It is therefore important to gain a fundamental understanding of the factors controlling oxygen surface exchange, such as defect chemistry and defect-related properties, degree of oxygen non-stoichiometry, surface composition and grain boundary properties. Basic engineering parameters (e.g., firing temperature, atmosphere and duration) determine morphology, microstructure and surface composition of the materials, and may therefore also be of influence. The oxygen exchange activity for a given material may be enhanced via infiltration and/or surface decoration with exchange-active second phases.

Main characterization techniques used to determine the oxygen surface exchange kinetics of fast ionic conducting oxides include ^{18}O-^{16}O isotopic exchange depth profiling method (IEDP), ^{18}O-^{16}O isotopic exchange gas phase analysis (IE-GPA), ^{18}O-^{16}O isotopic exchange pulse technique (PIE), electrical conductivity relaxation (ECR), electrochemical impedance spectroscopy under controlled atmosphere (humidity and pO_2). Data from, e.g., low energy ion scattering (LEIS) and X-ray photo electron spectroscopy (XPS) is used to relate the observed oxygen exchange kinetics to the surface and near-surface composition of the materials.

Major aim of my lecture is to present recent progress and challenges of studies towards understanding the oxygen surface exchange kinetics of single-phase and composite mixed ionic-electronic conducting oxides.