
# Electroceramics XIII

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## University of Twente, Enschede, The Netherlands

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| O.22 | **Equilibration kinetics of mixed ionic-electronic conducting materials at different oxygen partial pressures**<br>Christian Niedrig[1], Chung-Yul Yoo[2], Wolfgang Menesklou[1], Stefan Baumann[3], Stefan F. Wagner[1], Henny J.M. Bouwmeester[2], Ellen Ivers-Tiffée[1,4]<br>[1]Institut für Werkstoffe der Elektrotechnik (IWE), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, 76131; [2]Inorganic Membranes, MESA+ Institute for Nanotechnology, Faculty of Science and Technology, University of Twente, Enschede, Netherlands, 7500 AE; [3]Institut für Energie- und Klimaforschung (IEK-1), Forschungszentrum Jülich, Jülich, Germany, 52425; [4]DFG Center for Functional Nanostructures, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, 76131 |

For an application of mixed ionic-electronic conducting (MIEC) oxides, e.g., as solid oxide fuel cell (SOFC) cathodes, as high-temperature gas sensors or as oxygen-transport membrane (OTM) material, the kinetics of oxygen transport – namely the chemical diffusion coefficient $D^{\delta}$ and the surface exchange coefficient $k^{\delta}$ – are of fundamental importance as they determine the performance of the materials.

A common setup for the determination of $D^{\delta}$ and $k^{\delta}$ values is the conductivity relaxation method where the conductivity response of a bulk MIEC sample is monitored (and evaluated according to Crank's theory) after the ambient oxygen partial pressure $pO_2$ is abruptly changed using different gas mixtures. In the present study an alternative setup – a closed tubular zirconia "oxygen pump" with Pt electrodes – was employed to precisely control the $pO_2$ continuously within the entire range between $10^{-20}$ ... 1 bar at temperatures above 700 °C.

Conductivity relaxation measurements were performed on dense MIEC bulk samples of $Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_{3-\delta}$ (BSCF), $La_{0.58}Sr_{0.4}Co_{0.2}Fe_{0.8}O_{3-\delta}$ (LSCF), and $La_{0.6}Sr_{0.4}CoO_{3-\delta}$ (LSC) at $pO_2$ values between $10^{-6}$ and 1 bar in small $pO_2$ steps (thus remaining close to chemical equilibrium) at temperatures between 700 and 900 °C in order to determine $D^{\delta}$ and $k^{\delta}$ values as a function of temperature and $pO_2$.

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| O.23 | **Oxygen surface exchange kinetics of mixed oxide ionic-electronic conductors**<br>Chung-Yul Yoo[1], Bernard A. Boukamp[2], Henny J.M. Bouwmeester[1]<br>[1]Inorganic Membranes, Faculty of Science and Technology, MESA+ Institute for Nanotechnology, University of Twente, Enschede, Netherlands, 7500AE; [2]Inorganic Material Science Group, Faculty of Science and Technology, MESA+ Institute for Nanotechnology, University of Twente, Enschede, Netherlands, 7500AE |

Mixed oxide ionic-electronic conductors find potential applications in ceramic devices including oxygen separation membranes and solid oxide fuel cells (SOFC). Besides fast ionic transport, the challenge to researchers is to design oxide materials showing fast surface oxygen exchange kinetics between the gaseous phase and the oxide, allowing operation at intermediate temperatures (500-700°C). However, present understanding of the exchange kinetics on the surface of fast oxide ion conductors is still rudimentary. Recently, we developed a novel method, referred to as pulse-response isotopic exchange technique (PIE), for rapid measurement of the surface exchange kinetics. The method is based upon isotope analysis of an $^{18}O$-enriched gas phase effluent pulse after passage of a continuous-flow packed-bed microreactor loaded with the oxide powder. The measurements are carried out under isothermal and iso-$pO_2$ conditions. Since the method relies on gas phase analysis of the fractions of oxygen isotopomers with masses 36, 34 and 32 ($^{18}O_2$, $^{16}O^{18}O$, and $^{16}O_2$, respectively) by mass spectrometry also mechanistic information on the exchange reaction can be extracted from experiment. Results of