
Small decoration, big impact: Interplay between surface chemistry, transport properties, and oxygen exchange kinetics in mixed conducting oxides

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Résumé

Current Solid Oxide cells (SOC) shows limited stability and lifetime considering the high working temperature 800-1000°C. One solution is to lower the working temperature allowing a larger range of usable material and, in fine, higher stability. However, for this technology to stay competitive the choice of the material need to take into account the limited reaction kinetics at the electrodes at lower temperatures, which limits the cell performance. Then, one critical goal is to better understand the reaction pathways controlling the electrode kinetics, to be able to improve them. In the literature (1,2), it was shown for oxygen electrode that reaction kinetics at the electrode surface is directly dependent to the electrons availability at the surface. Indeed, they allow the reduction of O₂ into O₂⁻ before its diffusion through the bulk. It was deduced that conduction properties of the electrode material had a direct impact on reaction kinetics and could be limited by oxygen reduction and O₂⁻ diffusion through the bulk. A similar behavior was observed with the surface chemistry, which is directly linked to the gas adsorption and O₂ reduction, critical steps of the electrode-gas exchange. Although both surface chemistry and transport properties are key to the reaction kinetics, their interplay remains poorly understood.

Here, the approach is to modify the surface acidity of the electrode material by infiltrating metal oxides at the surface, the acidity being determined by Smith acidity scale (3). This simple protocol was proposed and tested by Nicollet and al.(4) on Pr_{0.1}Ce_{0.9}O_{2-δ}. In this presentation, a comparative study of two material Pr_{0.1}Ce_{0.9}O_{2-δ} from Nicollet and al. study and La_{0.6}Sr_{0.4}CoO_{3-δ} from unpublished results is presented. The oxygen exchange kinetics are measured by relaxation conductivity after infiltration of oxides of various acidities. It was shown that a small amount of oxides added at the surface had an important effect on the kinetics. The oxygen exchange kinetics spread over 7 orders of magnitude for Pr_{0.1}Ce_{0.9}O_{2-δ}, and over one order of magnitude for La_{0.6}Sr_{0.4}CoO_{3-δ}. The objective is to present in a simple way the interactions and effects of the added oxides at the surface of the electrode.

Keywords: Conductivity relaxation, Solid Oxide Cell, Pr_{0.1}Ce_{0.9}O_{2-δ}, La_{0.6}Sr_{0.4}CoO_{3-δ}, Catalysis, Acidity, Surface reactivity, Conduction properties

Références :

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