

High temperature chemical reactivity of potential SOFC materials in dry and wet gas atmospheres investigated by thermal analysis and in situ neutron powder diffraction

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Solid oxide fuel cells (SOFC) working around 900 °C have drawn a growing interest in the field of energy. Their operating temperature allows the use of complex combustible gases at the anode (natural gas, biomass gas). To prevent carbon deposition, contamination by sulfur and aging of the composite in the presence of water, one of the major challenges remains the replacement of the standard cermet anode material, Ni/YSZ (YSZ: yttria stabilized zirconia) with a mixed ionic and electronic conductor (MIEC).

In this view, manganite Ruddlesden-Popper (RP) phases; $n = 1$ $(\text{La,Sr})_2\text{MnO}_{4-\delta}$ and $n = 2$ $(\text{La,Sr})_3\text{Mn}_2\text{O}_{7-\delta}$ are promising SOFC anode materials [1,2] due to their good thermal stability in a reducing atmosphere and the mixed valence of Mn essential for electronic conductivity. The latter systems have not been studied for SOFC applications so far.

In this project, two RP $n = 2$ compositions, $\text{LaSr}_2\text{Mn}_2\text{O}_7$ and $\text{La}_{1.2}\text{Sr}_{1.8}\text{Mn}_2\text{O}_7$, are prepared by two synthesis methods. High temperature in situ X-ray diffraction (XRD) and neutron diffraction (D20/ILL, Grenoble) combined to thermogravimetric analysis (TGA) have been carried out under H_2 and air flow to characterize the behavior in operating SOFC conditions. The powder samples have been sintered by spark plasma sintering (SPS) for conductivity measurements. In addition thermal stability in wet atmosphere has been investigated.

References

[1] Broux, T., Prestipino, C., Bahout, M., Hernandez, O., Swain, D., Paofai S., Hansen, T. and Greaves, C., Unprecedented High Solubility of Oxygen Interstitial Defects in $\text{La}_{1.2}\text{Sr}_{0.8}\text{MnO}_{4+\delta}$ up to $\delta \sim 0.42$ Revealed by In Situ High Temperature Neutron Powder Diffraction in Flowing O_2 , Chemistry of Materials, 2013, 25(20): p. 4053-4063.

[2] Broux, T., Bahout, M., Hernandez, O., Tonus, F., Paofai S., Hansen, T. and Greaves, C., Reduction of Sr_2MnO_4 investigated by high temperature in situ neutron powder diffraction under hydrogen flow, Inorganic Chemistry 2013, 52 (2), pp.1009-17.

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