

BaZrO₃ and SrCeO₃ – Choosing the right partner materials

Reactions between state of the art ionically conducting ceramic materials have been assessed with the goal of predicting systems which will demonstrate long term stability in high temperature application.

Ceramic materials which can conduct protons or oxide ions are of enormous interest for applications such as fuel cells and water electrolyzers, which will form the core of the forthcoming hydrogen economy. These devices are now reaching maturity, and are making the move from laboratory to commercial application. As they do so however, there is a need to assess the long term stability and reliability of the assemblies as a whole, as reactions occurring at solid-solid interfaces, and physical incompatibility of materials upon thermal cycling, can lead to catastrophic device failure.

As part of the Functional Oxides for Energy Technology (FOET) project, the Inorganic Materials and Ceramics Research Group is conducting a systematic investigation into the partnering of solid oxide component materials, focussing on matching proton conducting electrolytes from the AZrO₃ and ACeO₃ families (where A=Ca, Sr,

Ba) with appropriate solid oxide component materials. State of the art in this respect are doped derivatives of the perovskite and perovskite- related LaMO₃ and La₂MO₄ type oxides (where M=Cr, Mn, Fe, Co, Ni). Via careful choice of dopant the ionic and electronic conductivity in these systems can be tailored toward specific function within an electrochemical device, with flexibility in the choice of transition metal providing options with respect to catalytic activity.

Our investigation of these systems has applied BaZrO₃ and SrCeO₃ as representative materials, and by assessing the reactivity of these with the component candidates considerable information has been gleaned with respect to prediction of compatible materials for the wider AZrO₃/ACeO₃ families. We can predict generally good chemical compatibility of both LaMO₃ and La₂MO₄ type systems with the zirconate family, but for the cerates only heavily doped La_{2-x}A_xMO₄ systems are compatible. Additionally, insight has been obtained into the underlying dynamics of the reactions which occur. The cerate systems in particular show surprisingly fast reaction dynamics, enabled by fast transport of Sr through the CeO₂ secondary phase (Fig. 1).

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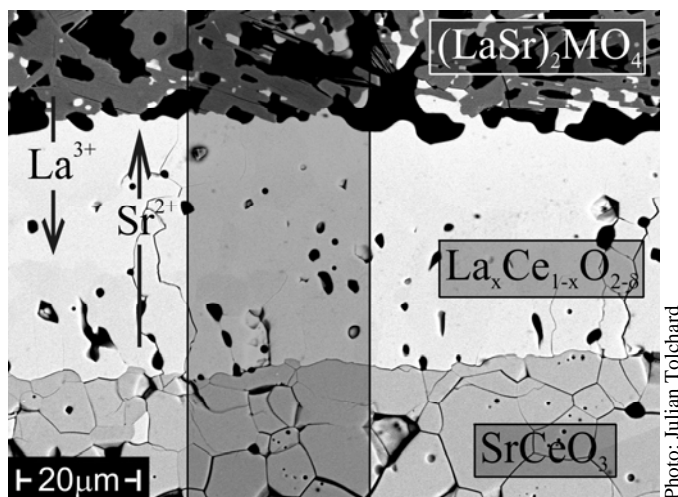


Fig. 1
Diffusion couple of SrCeO₃ and LaMnO₃ after extended firing at 1300°C.

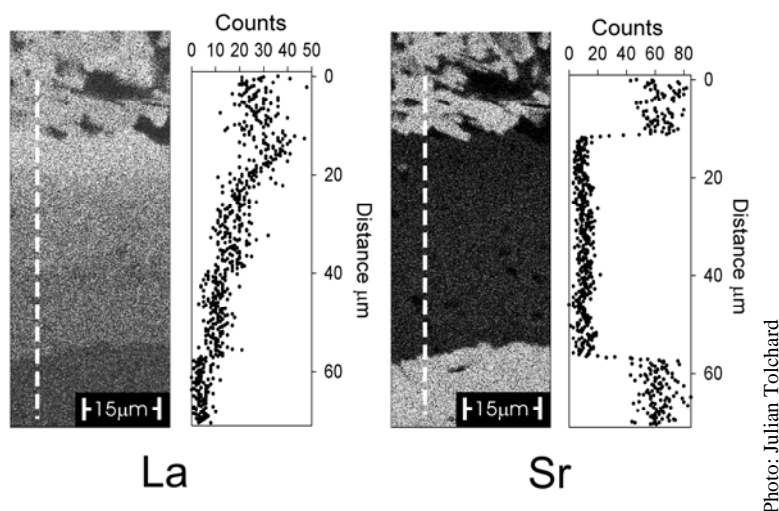


Fig. 2
EDS Element maps taken from the shaded area shown in Fig. 1.