Mechano-chemical engineering: Can strained oxide ion conductors provide a route to next-generation electrochemical devices?

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Traditionally, the development of new materials for electrochemical devices, such as solid oxide fuel cells (SOFCs), has been based upon new chemical compositions and structures. Yet in recent years, the effects of mechano-chemical coupling, via strain engineering, has received considerable interest for improving ion transport and surface reactivity in SOFCs.

In this presentation, the effect of lattice strain on the oxide ion conductivity and the chemical stability of oxides of importance to SOFCs will be discussed. In this work, we have studied the effects of strain on the transport properties of oxygen ion based electrolytes such as yttria-doped zirconia and rare earth-doped ceria, when grown in thin film geometries. Here, we have investigated oxygen ion conductivity as a function of substrate induced tensile and compressive strain, both electrically and using a novel isotope tracer diffusion technique.

Given the significant interest in the ionic transport in strained oxides, there has been surprisingly little work studying the stability of such systems, despite devices being required to operate at high temperatures for extended lengths of time. To address this issue, we assess the implications of lattice strain on materials degradation from dopant segregation in typical fluorite and perovskite structures, as a path towards identifying strain states for optimal device performance.

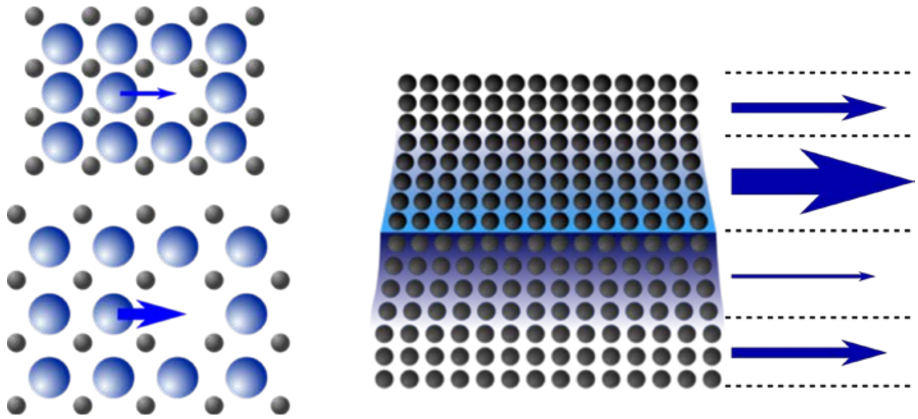

Figure 1: Schematic showing strain in a lattice and at an interface between two materials with a different lattice parameter.