Fall 11-11-2015

Enhancing grain boundary ionic conductivity in mixed ionic electronic conductors

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ENHANCING GRAIN BOUNDARY IONIC CONDUCTIVITY IN MIXED IONIC-ELECTRONIC CONDUCTORS

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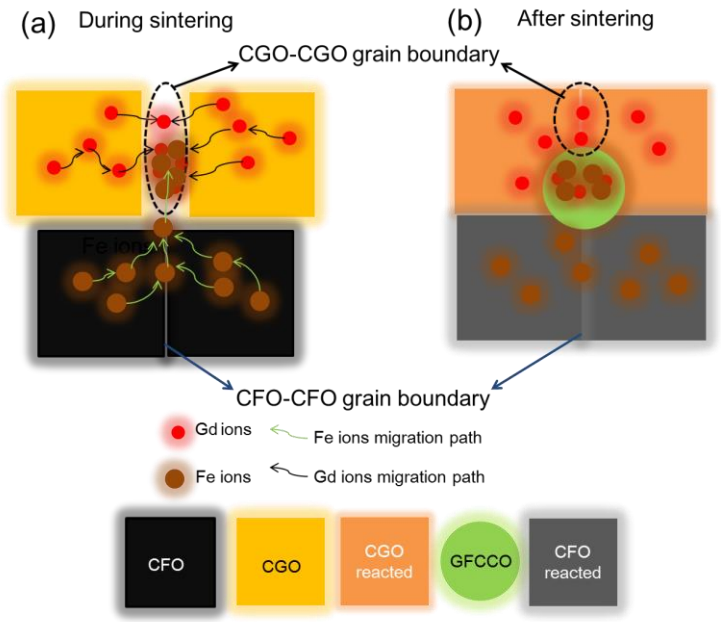
Key Words: ionic conductors, solid oxide fuel cells, separation membranes, grain boundary

The emergent properties arising from the interactions of phases including interfacial contributions and phase evolution at the mesoscale present new opportunities, as well as challenges, for materials performance and functionality. Mixed ionic-electronic conductors are widely used in devices for energy conversion and storage. Grain boundaries in these materials have nanoscale spatial dimensions, which can generate substantial resistance to ionic transport due to dopant segregation. Here, we report a concept of targeted phase formation in a $Ce_{0.8}Gd_{0.2}O_{2-\delta}$-$CoFe_2O_4$ (CGO-CFO) composite that serves to enhance the grain boundary ionic conductivity. Using spatially resolved electron microscopy, we probed the grain boundary charge distribution and chemical environments altered by the phase reaction between the two constituents. The formation of an emergent phase successfully avoided segregation of the Gd dopant and depletion of oxygen vacancies at the $Ce_{0.8}Gd_{0.2}O_{2-\delta}$-$Ce_{0.8}Gd_{0.2}O_{2-\delta}$ grain boundary. This resulted in superior grain boundary ionic conductivity as demonstrated by the enhanced oxygen permeation flux. This work illustrates the control of mesoscale level transport properties in mixed ionic-electronic conductor composites through processing induced modifications of the grain boundary defect distribution. Implications for controlling grain boundary composition in diverse applications of ceramic-ceramic composites such as nuclear waste immobilization will be discussed.

Figure 1 – Schematic of the proposed phase reaction mechanism between CGO and CFO. (a) Dopants (mainly Gd and Fe ions) moved inside the CGO-CFO composites during the sintering process, (b) the final state of the CGO-CFO composites.



Y. Lin, S. Fang, D. Su, K. Brinkman* and F. Chen*, "Enhancing grain boundary ionic conductivity in mixed ionic electronic conductors" *Nature Communications*, **2015**, 6, 6824. * Corresponding Authors

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