New Materials, structures and concepts for Solid Oxide Cells

Prof. John T. S. Irvine
School of Chemistry, University of St Andrews, St Andrews, Fife KY16 9ST, UK

Tel.: +44 1334 463817
jtsi@st-and.ac.uk

The key technical challenges that fuel cell developers need to address in advancing this technology are performance, durability and cost. All three need to be achieved in parallel; however, there is often competitive tensions meaning that e.g. performance is achieved at the expense of durability. The greatest challenge facing Solid oxide cells (SOC), in both fuel and electrolysis cell modes (i.e SOFCs and SOECs) is to deliver high, long-lasting electrocatalytic activity while ensuring cost and time-efficient electrode manufacture [1]. Ultimately, this can best be achieved by growing appropriate nanoarchitectures under operationally relevant conditions, rather than through intricate ex situ procedures. Here we present the growth of a finely dispersed array of anchored metal nanoparticles on an oxide electrode, yielding a sevenfold increase in fuel cell maximum power density. These new electrode structures are capable of delivering high performances in both fuel cell and electrolysis mode (e.g. 2 Wcm-2 in humidified H_2 and 2.75 Acm^{-2} at 1.3 V in 50% H_2O/N_2, at 900°C). Both the nanostructures and corresponding electrochemical activity show no degradation over 150 hours of testing. These results not only prove that in operando treatments can yield emergent nanomaterials, which in turn deliver exceptional performance, but also provide proof of concept that electrolysis and fuel cells can be unified in a single, high performance, versatile and easily manufacturable device. This opens exciting new possibilities for simple, quasi-instantaneous production of highly active nanostructures for reinvigorating SOC cells during operation.