A study of bimetallic catalysis for lower temperature operation of solid oxide fuel cells

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Scientific Background / Current Research
Recent experiments by the group have begun the examination of bimetallic heterogeneous catalysis in the Ru/Mn bimetallic system whereby upon the annealing of thin films of MnO on Ru surfaces the dissociation of MnO occurs at much lower temperatures than is otherwise the case. This potential opens a route for a lower temperature oxygen reduction reactions (ORR) at Ru/Mn interfaces as a cathode material in future solid oxide fuel cells (SOFC), where the high operational temperature (>800 °C) required for current, state of the art, SOFC cathodes has been identified as the major barrier to widespread SOFC use. The target temperature for future low temperature SOFCs is 500 °C and alternative bimetallic cathodes including Ru/Mn, Ru/Bi and Mn/Mg, will be investigated. In particular oxygen reduction on Ru/Mn surfaces can be achieved in UHV conditions, allowing changes in the chemical composition and electronic structure to be monitored during the oxygen reduction reaction using in-situ UHV analysis techniques.

Project: The project will take a wholly in-situ surface science approach to the study of bimetallic catalysis in the Ru/Mn system. Several strands of investigation will occur with investigations via amorphous Ru/Mn bilayer systems, Ru,Mn, alloys and Mn epitaxial thin films on Ru(0001) single crystal surfaces in order to both understand the origin of the lowered MnO dissociation temperature and to investigate and optimize the efficacy of the process whereby such Ru/Mn thin films might be used in lower temperature solid oxide fuel cell devices. The techniques by which the investigations will occur are all in-situ ultra-high vacuum (UHV) surface science techniques principally laboratory based ultraviolet and x-ray photoemission spectroscopy (UPS/XPS), as well as low energy electron diffraction (LEED), thermal desorption spectroscopy (TDS) and electrochemical measurements. Electronic structure investigations intended to probe the efficacy of d-band theory to the Ru/Mn system may then also require x-ray spectroscopic investigations at synchrotron radiation facilities employing both valence band XPS, x-ray absorption spectroscopy (XAS) and x-ray emission spectrosopies (XES). Further experiments at ambient pressure XPS facilities will examine near-real world operating conditions.

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More information / References
A detailed project description available upon request.