The use of high temperature ceramic oxides in catalytic and energy applications

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High temperature electroceramic oxides can find uses in a variety of applications such as catalyst supports, electrolytes and electrodes for SOFCs, permselective separation membranes and oxygen carriers for chemical looping processes. These materials often belong to the perovskite family of mixed metal oxides (ABO_3) and can be tailor-made to tune their conducting properties (oxygen ion, protonic, electronic and mixed conductivity) to suit the application.

The group of Applied Catalysis and Solid State Electrochemistry at Newcastle University is very active in this area with projects that cover different applications of high temperature ceramic oxides. In particular our research interests include:

<u>High temperature ceramic membranes</u>

Oxygen permeable ceramic membranes can be utilised in a variety of clean energy applications such as a natural gas combustion process to produce virtually pure CO_2 offering a realistic solution for the mitigation of CO_2 emissions. These materials can also be used for ultra-pure hydrogen production as they can be designed with tailor-made perm-selective properties that allow them to be used for hydrogen separation. Our work is focused on exploiting the water-gas-shift and syngas routes to hydrogen production using mixed ionic-electronic conducting micro-tubular membranes.

<u>Chemical Looping</u>

Our focus is to investigate the use of perovskite mixed metal oxides in a methane steam reforming chemical looping (CL) processes for the production of pure hydrogen with combined CO_2 capture or syngas production. By using an appropriate oxygen carrier a chemical looping process temporally separates the oxidation and reduction products taking place during the methane reforming. As the methane and air is not in contact, the resulting hydrogen product is unmixed with the carbon-containing product. Perovskites are expected to have a longer lifetime and similar activity compared to transition metal oxides, such as iron oxide, currently under study for CL processes.

<u>Electrochemical promotion on catalysis</u>

Electrochemical promotion is an exciting area of catalysis that investigates the role of spillover species on the catalytic properties of a metal catalyst interfaced with a ionic or mixed ionic-electronic conducting support. Heterogeneous catalysis can benefit by the understanding of EPOC and catalyst-support interactions that would allow the development of 'tunable' catalysts. Our interest in EPOC is to investigate the mechanism of promotion by using novel reactor configurations, model catalysts and by studying the role of surface impurities on the catalytic and spillover processes.