Novel Electrode materials for Low-Temperature Solid Oxide Fuel Cells (SOFCs)

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Composites consisting of silver and bismuth vanadates exhibit remarkable catalytic activity for oxygen reduction at 500-550^oC and greatly reduce the cathode-electrolyte (doped ceria) resistances of low temperature SOFCs, down to about 0.53 Ωcm^2 at 500^oC and 0.21 Ωcm^2 at 550^oC. The observed power densities of 231, 332, and 443 $mWcm^{-2}$ at 500, 525 and 550^oC, respectively, make it possible to operate SOFCs at temperatures about 500^oC. While the long-term stability of the cathodes is yet to be characterized, the demonstrated remarkable performances (low interfacial resistances and high power densities) at low temperatures are very encouraging, implying that a new generation of low-temperature SOFCs is hopeful. Significant reduction in operating temperature will dramatically reduce not only the cost of materials but also the cost of fabrication. It also implies greater system reliability, longer operational life, and increased potential for mobile applications. Low-temperature SOFCs have great potential to be affordable for many applications, including residential and automotive applications.

In-situ FTIR emission spectroscopy is capable of probing gas-solid interactions as electrochemical reactions take place under practical conditions for fuel cell operation, providing valuable information on surface chemistry and electrochemical processes as electrochemical reactions take place. Key issues with respect to electrochemical cell operation, spectrometric stability, and spectroscopic sensitivity have recently been demonstrated in our lab. Infrared is very sensitive to several forms of adsorbed oxygen, including peroxide ions O_2^{2-} (800-900 cm^{-1}), superoxide ions O_2^{-} (1040-1190 cm^{-1}), and adsorbed O_2 (1500-1700 cm^{-1}). We have successfully identified which surface oxygen species is present under a particular electrical or chemical condition and have been able to deduce the reaction mechanisms. This technique will be used to probe the gas-solid interactions at or near the TPB and on the surfaces of mixed-conducting electrodes in an effort to understand the molecular processes relevant to the intrinsic catalytic activity.

List of Manuscripts Receiving Support from the Grant

1. C. Xia and M. Liu, "Novel Electrode Materials for Low-Temperature Solid Oxide Fuel Cells", *Advanced Materials*, Accepted.

2. X. Lu, P. Faguy, and M. Liu, "In Situ Potential Dependent FTIR Emission Spectroscopy: A New Technique for Structural Studies at Functioning Solid Oxide Fuel Cell Interfaces", *Electrochem. & Solid State Letters*, to be submitted.

3. C. Xia, W. Rauch, W. Wellborn, and M. Liu, "Functionally Graded Electrodes", Electrochemical and *Solid State Letters*, to be submitted