Isolation of the Working Electrode on Planar Electrolytes Using a 2-D Microelectrode.

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The use of a reference electrode to isolate the half-cell response of a SOFC becomes increasingly difficult as the electrolyte becomes very thin. In order to address this, we have developed a technique involving a 2-D strip microelectrode that aids in the isolation of half-cell impedances and overpotentials. The technique utilizes a high-temperature insulating mask, fabricated using a low-cost slurry-based technique, to regulate where the working electrode (WE) and reference electrode (RE) make contact to the electrolyte. By this means it is possible to regulate the potential distribution within the electrolyte, mitigating quantitative scaling errors, and eliminating frequency "cross-talk" between the counter electrode (CE) and the WE.

SOFC cathodes made from both porous Pt and porous $La_{1-x}Sr_xCoO_{3-\delta}$, were screen-printed and fired onto samaria-doped ceria electrolyte (SDC). As discussed in this paper, these measurements have shown that 1) the overpotential of the half cells are generally not symmetric, differing in anodic and cathodic directions. 2) The addition of the anodic and cathodic overpotentials generally yields an accurate prediction of the symmetric cell response. 3) Lateral current distribution is an issue for the accuracy of these measurements, and we have studied additional cell designs (in addition to Fig. 2), which potentially mitigate this effect. 4) The microelectrode half cells do an excellent job of frequency isolation, virtually eliminating any measurable cross-talk effects from the CE. 5) The technique can be quantitative, accurately predicting the *i-V* characteristics and impedance of a full-scale cell based on half-cell measurements on a microelectrode.

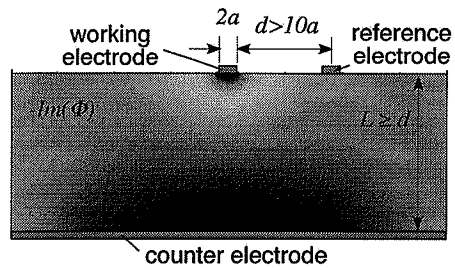

Fig. 1. Calculated potential distribution surrounding a 2-D "strip" microelectrode. By shrinking the working electrode to a narrow strip, ohmic loss is confined to a hemicircular region, providing high frequency isolation and independence of reference drift.

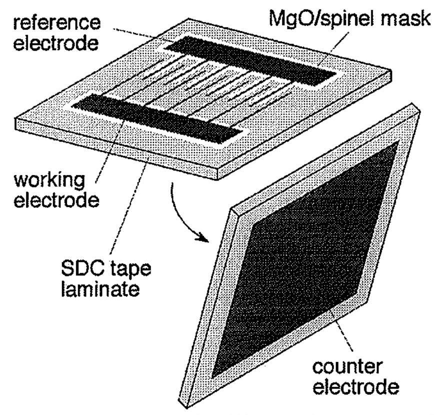

Fig. 2. Schematic illustrating one of our experimental implementations of the microelectrode concept in Fig. 1. An insulating mask containing a mix of MgO and spinel is cast and fired onto the electrolyte substrate, regulating where the working and reference electrodes make contact.

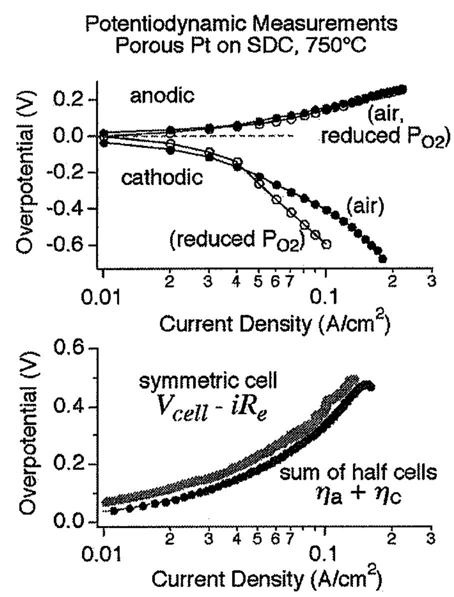

Fig. 3. Comparison of half cell measurements for Pt on samaria-doped ceria (SDC) to that of a symmetric cell. Note that the total electrode losses of the symmetric cell (V_{cell}-iR) agree closely with the sum of the anodic and cathodic overpotentials (measured independently using the microelectrode half-cells).