TITLE: **Novel Composite Materials for SOFC Cathode-Interconnect Contact**

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OBJECTIVES:

The overall goal of the research project is to develop a novel low-cost and damage-tolerant Ag-base alloy/perovskite composite material with low Ag evaporation/migration, suitable coefficient of thermal expansion, oxidation resistance, electrical conductivity, chemical stability and compatibility tailored compositionally and microstructurally for intermediate-temperature solid oxide fuel cell (SOFC) cathode-interconnect contact application. More specifically, the objectives of this research project include:

(1) **Alloy design of an Ag-based alloy with significantly reduced Ag evaporation/migration**. The content of other noble metals such as Au, Pd, Pt, and other alloying additions will be varied and their effects on the Ag evaporation/migration of the alloy system will be experimentally assessed. The alloy composition range with lowest Ag evaporation/migration rate will be identified.

(2) **Optimization of the processing and the microstructures of Ag alloy/perovskite composites**. The Ag-based alloy powders with the composition defined by the alloy design efforts will be synthesized using cost-effective fabrication routes. The powders should be uniform in composition and microstructure, and preferentially should be composed of fine particles (e.g. nano-sized) for facilitating low-temperature sintering. The size, morphologies, volume percentages of the Ag-based alloy powders and the perovskite powders will be varied to optimize the contact paste.

(3) **Demonstration/assessment of the performance of the new contact materials.** The new contact materials will be applied to interconnect/cathode interface and their performance will be assessed via in-depth characterization of microstructures, thermal cycling resistance, compatibility/stability with interconnect and cathode, as well as in-cell testing. The potential of this new class of contact materials will be demonstrated.

Accomplishments to Date

The evaporation behavior of pure Ag in both oxidizing and reducing atmospheres has been assessed. The weight loss of pure Ag due to evaporation was found to increase linearly with exposure time for both environments. Even though the specimens exbihited different surface morphologies after exposure in the oxidizing and reducing environments, the exposure atmosphere did not have significant effect on Ag evaporation rate; i.e., pure Ag exhibited very similar evaporation rate in atmospheres such as air, air+3%H_2O, Ar+5%H_2, and Ar+5%H_2+3%H_2O, etc., provided that the gas flow rate was the same. As the gas flow rate increased, the weight loss of pure Ag initially increased linearly and then reached a plateau at a flow rate of about 1.0 $cm.s^{-1}$; further increase in the flow rate had no effect on the Ag evaporation rate. To determine the effect of temperature on Ag evaporation rate, a relatively high flow rate of 1500ml/min was selected as a standard flow rate and the test temperature was varied from 750ºC to 900ºC. As the temperature increased, the Ag evaporation rate increased drastically. The activation energy for Ag evaporation was calculated to be 281.7 kJ/mol, very close to the heat of atomization for pure Ag reported in literature.

An Ag+$La_{0.8}Sr_{0.2}CoO_3$ composite was successfully synthesized through a glycine nitrate process (GNP). After calcinations at 700°C for 5h, a well-distributed two-phase composite was formed. The as-synthesized powder consisted of agglomerates of very fine particles of less than 1μm in diameter. Ball milling was found effective to break down the agglomerates to below 1μm. These powders with fine particle size are expected to exhibit desirable sinterability for the SOFC cathode-interconnect contact applications.

FUTURE WORK

A number of binary and ternary Ag alloys will be prepared to evaluate the effect of alloying additions on the Ag evaporation. The alloying elements will include noble metals and other transition metals as well as surface-active elements. The evaporation rate of these alloys will be measured and potential alloying elements which can significantly reduce the Ag evaporation will be identified. A series of Ag+perovskite composites with different particle size will be produced through ball milling of the synthesized powders. The sintering behavior of these composites will be studied. Other synthesis route for generating ultra-fine (e.g. nano-size) powders will also be sought.

LIST OF PAPER PUBLISHED, CONFERENCE PRESENTATIONS, STUDENTS SUPPORTED UNDER THIS GRANT

Publications:

Evaporation Behavior of Pure Ag at Elevated Temperatures, Z.G. Lu, J.H. Zhu, and Y.Q. Qian (manuscript in preparation)

Presentations: N/A

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