ABSTRACT:

SOLID OXIDE FUEL CELL NANO-MICRO-COMPOSITE CATHODE INFILTRATED PARTICLE SIZE CONTROL AND OXYGEN SURFACE EXCHANGE RESISTANCE DETERMINATION

For the past decade, nano-sized Mixed Ionic Electronic Conducting (MIEC) – micro-sized Ionic Conducting (IC) composite cathodes produced by the infiltration method have received much attention in literature [3-11] due to their decreased polarization resistances ($R_p$) at lower operating temperatures. Reduction of the infiltrated MIEC oxide nano-particle size and the intrinsic MIEC oxygen surface exchange resistance ($R_s$) are two key parameters used to reduce Nano-Micro-Composite Cathode (NMCC) operating temperature. Unfortunately, previous studies have not found a reliable method to control or reduce infiltrated nano-particle size. The $R_s$ measurements for most SOFC MIEC materials vary by 2-5 orders of magnitude [13] depending on the sample or testing conditions, and while MIEC $R_s$ measurements have been concluded on
bulk and thin films, infiltrated MIEC $R_s$ values have never been concluded. The work in this thesis remedies these knowledge gaps in two ways.

First, two processing techniques; precursor nitrate solution desiccation and ceria oxide pre-infiltration were developed to systematically produce a reduction of $\La_{0.6}\Sr_{0.4}\Co_{0.8}\Fe_{0.2}\O_3$ (LSCF) infiltrated nano-particle size from 50 nm to 22 nm. This particle size reduction reduced SOFC operating temperature, (defined as the temperature where $R_P=0.1 \ \Omega \ \text{cm}^2$) from 650°C to 540°C. Second, infiltrated MIEC $R_s$ values were determined for the first time through finite element modeling calculations on 3D Focused Ion Beam-Scanning Electron Microscope (FIB-SEM) reconstructions of electrochemically characterized infiltrated electrodes for each MIEC composition. The calculated NMCC infiltrate MIEC $R_s$ values were closer to the upper subset of previously reported $R_s$ values.

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