

Solid Oxide-Molten Carbonate Nano-composite Fuel Cells: Particle Size Effect

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Varying the amount of specific interface area in the $\text{CeO}_2\text{-Na}_2\text{CO}_3$ nano-composite fuel cell electrolyte helped reveal the role of interfaces in ionic conductivity. We mixed ceria particles with micrometer or nanometer size distributions to obtain a specific surface area (SSA) in the composite from $47 \text{ m}^2/\text{g}$ to $203 \text{ m}^2/\text{g}$. Microstructural investigations of the nano-composite showed that the Na_2CO_3 phase serves as the glue in the microstructure, while thermal analysis revealed a glass transition-like behavior at 350°C . High SSA enhanced the ionic conductivity significantly at temperatures below 400°C . Moreover, the activation energy for the Arrhenius conductivity (σT) of the composites was lower than that of the Na_2CO_3 phase. This difference in the activation energies is consistent with the calculated dissociation energy of the carbonate phase. The strong dependence of conductivity on the SSA, along with differences in the activation energies, suggests that the oxide surface acted as a dissociation agent for the carbonate phase. A model for the solid composite electrolyte is proposed: in the nano-composite electrolyte, the oxide surface helps Na_2CO_3 dissociate, so that the "liberated" ions can move more easily in the interaction region around the oxide particles, thus giving rise to high ionic conductivities.