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Wide bandgap oxides for low-temperature single-layered nanocomposite fuel cell

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Abstract

A composite of wide bandgap lithium-nickel-zinc-oxide (LNZ) and gadolinium-doped-cerium-oxide (GDC) was systematically analyzed for a low-temperature nanocomposite fuel cell in a so-called single-component configuration in which the electrodes and electrolyte form a homogenous mixture. We found that the operational principle of a single-layer fuel cell can be explained by electronic blocking by the oxide mixture with almost insulator-like properties in the operating voltage regime of the fuel cell, which will prevent short-circuiting, and by its catalytic properties that drive the fuel cell HOR and ORR reactions. The resistance to charge transport and leakage currents are dominant performance limiting factors of the single-component fuel cell. A test cell with Au as current collector reached a power density of 357 mWcm^{-2} at 550°C . Changing the current collector to a $\text{Ni}_{0.8}\text{Co}_{0.15}\text{Al}_{0.05}\text{LiO}_2$ (NCAL) coated Ni foam produced 801 mWcm^{-2} , explained by better catalytic properties. However, utilizing NCAL coated Ni foam may actually turn the 1-layer fuel cell device into a traditional 3-layer (anode-electrolyte-cathode) structure. This work will help in improving the understanding of the underlying mechanisms of a single-layer fuel cell device important to further develop this potential energy technology.

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