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Praseodymium and gadolinium doped ceria as a cathode material for low temperature solid oxide fuel cells

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Abstract

Mixed ionic electronic conducting praseodymium and gadolinium doped ceria **(**$Pr_xCe_{0.95-x}Gd_{0.05}O_{2-\delta}$ ($0.15 \leq x \leq 0.40$)) compositions have been studied as a cathode material for low temperature solid oxide fuel cells. Four compositions of $Pr_xCe_{0.95-x}Gd_{0.05}O_{2-\delta}$ (PCGO) have been prepared by varying the praseodymium content. Phase formation, thermal expansion, ionic conductivity, electronic conductivity, ionic transference number and electrochemical performance have been investigated. X-ray diffraction results indicate that PCGO samples crystallize in the fluorite structure, and the lattice volume decreases with increasing praseodymium content, x. The coefficient of thermal expansion increases with increasing x, and at x = 0.2 shows an optimum value of 12 x 10^{-6} K^{-1}. Ionic transference number decrease while electronic conductivity increase with increasing x. It has been found that electronic contribution to the total conductivity is higher than ionic contribution for all compositions. The praseodymium doping with cerium dioxide introduces impurity bands within the ceria band gap and facilitates the electronic transition from valance band to conduction band through praseodymium impurity levels. The single cell with configuration, $Pr_{0.2}Ce_{0.75-x}Gd_{0.05}O_{2-\delta}$-$Ce_{0.80}Gd_{0.20}O_{2-\delta}$//$Ce_{0.80}Gd_{0.20}O_{2-\delta}$//NiO-$Ce_{0.80}Gd_{0.20}O_{2-\delta}$ delivers a maximum power density of 98 mW cm^{-2} at 650 °C.

Key words: Solid oxide fuel cell, Cathode material, Ionic transference number, Electronic conductivity, mixed ionic electronic conductor