Synthesis and characterization of $\text{NdBaMn}_{1.5-x}\text{Co}_{0.5}\text{Nb}_x\text{O}_{5+\delta}$ ($x=0, 0.1, 0.2$) as cathode materials for IT-SOFCs

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The effect of Nb substitution on structural characteristics, thermal expansion behavior, electrical properties and catalytic activity for oxygen reduction reaction (ORR) of the layered perovskite oxides $\text{NdBaMn}_{1.5-x}\text{Co}_{0.5}\text{Nb}_x\text{O}_{5+\delta}$ ($x=0, 0.1, 0.2$) has been investigated. After doping with Nb at B-site, the thermal expansion coefficient (TEC) value of $\text{NdBaMn}_{1.5-x}\text{Co}_{0.5}\text{Nb}_x\text{O}_{5+\delta}$ increases slightly. The average TEC of $\text{NdBaMn}_{1.5}\text{Co}_{0.5}\text{O}_{5+\delta}$, $\text{NdBaMn}_{1.4}\text{Co}_{0.5}\text{Nb}_{0.1}\text{O}_{5+\delta}$ and $\text{NdBaMn}_{1.4}\text{Co}_{0.5}\text{Nb}_{0.2}\text{O}_{5+\delta}$ are $12.89 \times 10^{-6} \text{K}^{-1}$, $13.55 \times 10^{-6} \text{K}^{-1}$ and $13.38 \times 10^{-6} \text{K}^{-1}$, respectively, which are much lower than that of Co-based layered perovskites. The electrical conductivity of $\text{NdBaMn}_{1.5-x}\text{Co}_{0.5}\text{Nb}_x\text{O}_{5+\delta}$ ($x=0, 0.1, 0.2$) samples decrease slightly with Nb content increasing due to the reduction of charge carriers. The doping of Nb greatly benefits the catalytic activity for oxygen reduction reaction. The adsorption/desorption of the molecular oxygen, bulk or surface oxygen diffusion processes during the ORR are improved by Nb doping. The R_p of $\text{NdBaMn}_{1.4}\text{Co}_{0.5}\text{Nb}_{0.2}\text{O}_{5+\delta}$ is $0.07 \Omega \text{cm}^2$ at 800°C which is triple lower than that of $\text{NdBaMn}_{1.5}\text{Co}_{0.5}\text{O}_{5+\delta}$ ($0.21 \Omega \text{cm}^2$ at 800°C). $\text{NdBaMn}_{1.4}\text{Co}_{0.5}\text{Nb}_{0.1}\text{O}_{5+\delta}$ and $\text{NdBaMn}_{1.4}\text{Co}_{0.5}\text{Nb}_{0.2}\text{O}_{5+\delta}$ samples exhibit low thermal expansion and high catalytic activity as promising cathode materials for IT-SOFCs.

Keywords: IT-SOFCs; cathode; Nb doping ; electrochemical performance.

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