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Synthesis and electrical characterization of $Na_xNi_{1-x}O_2$ compositions

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Sodium layered oxide compounds ($Na_xM_{1-x}O_2$) have drawn significant attention as cathode materials for Na-ion batteries (NIB). Their Li analogues have already been comprehensively understood. In this study, powder compositions of $(Na_xNi_{1-x})O_2$, (x = 0.1, 0.25, 0.5, 0.75) were prepared by the Pechini method. For that, metal nitrates of $NaNO_3$ and $Ni(NO_3)_2.6H_2O$ were mixed according to stoichiometric formula of the nominal compositions. The powder synthesis process was completed by calcining the ash product at 800 °C for two hours in air. The synthesized powders were uni-axially pressed at 150 MPa and the green pellets were subsequently sintered at 800 °C for two hours in static air. The electrical conductivity of these materials were determined by performing d.c. electrical conductivity measurements on sintered pellets by the four-probe method. The conductivity measurements were performed in a cyclic manner on heating and cooling in air, in the temperature range 25 - 200 ^oC.

This study revealed the possibility of synthesizing $Na_xNi_{1-x}O_2$, x = 0 - 0.75 compositions by the Pechini wet chemical synthesis technique. All these prepared materials showed an increase in conductivity in an exponential manner with increasing ambient temperature. This is a good indication of the semiconducting nature, which is the main requirement for an electrode material. In this $Na_xNi_{1-x}O_2$ system, the x = 0.1 composition showed a sufficiently high electrical conductivity of 3.5×10^{-3} S/cm at room temperature. These achievements in electrical conductivity indicate the potential of $Na_xNi_{1-x}O_2$ compositions for NIB cathode application.

Keywords: Electrical conductivity, electrode materials, Na-ion batteries, Pechini method, sodium layered oxide compounds

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