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$LiNi_{1-x}Co_xO_2$, x = 0 – 0.5 as potential electrode materials for electrochemical energy conversion

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To be selected for electrochemical energy conversion applications such as fuel cells and batteries, a candidate electrode material must possess adequate electrical conductivity to transfer electrical charge. This work is based on synthesis and electrical conductivity determination of $LiNi_{1-x}Co_xO_2$ compositions for the positive electrode application in electrochemical energy conversion devices such as Molten Carbonate Fuel Cell (MCFC) and rechargeable Lithium Ion Battery (LIB). It was carried out by synthesising the $LiNi_{1-x}Co_xO_2$, x = 0 – 0.5 novel candidates using a novel wet-chemical processing technique, the glycine nitrate combustion process in the form of fine powder. The prepared powders were subjected to phase analysis by X-ray diffraction (XRD, Philips diffractometer using monochromatic Cu K_α radiation). The electrical conductivity of the prepared materials was determined by the d.c. four probe technique. The solid specimens for this were prepared by pelletizing the synthesised powder by cold uni-axially pressing at 200 MPa and subsequently sintering at 1000 °C for two hours.

The XRD phase analysis revealed the existence of a solid solution of the *Fm3m* cubic structure in the compositions up to x = 0.2. This solid solution can be related to the *Fm3m* cubic rock-salt structure of NiO. The phase analysis further indicates the formation of the secondary phase of a *R3m* layered structure in the compositions of x > 0.2. This secondary *R3m* phase can be attributed to the formation of a layered structure of $LiCoO_2$.The electrical conductivity of the prepared compositions increased drastically to a maximum with an increase of x up to 0.2 followed by a decrease in the conductivity. Accordingly, the composition of x = 0.2 possesses the highest conductivity among the investigated compositions. Moreover all the compositions with x > 0.1 show an adequate electrical conductivity required for the MCFC cathode (1 S/cm at 650 ^{0}C) as well as for the LIB cathode (0.01 S/cm at 25 ^{0}C). Therefore, this study revealed the promising characteristics of these $LiNi_{1-x}Co_xO_2$, x = 0 – 0.5 compositions for both MCFC and LIB cathode applications.

Keywords: Electrochemical energy conversion, electrode materials, lithium ion battery, lithium transition metal oxides, molten carbonate fuel cell

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