

Synthesis and electrical characterisation of LiCoO₂, LiFeO₂ and NiO binary compositions

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From the viewpoint of cost and efficiency, semi-conductive oxide ceramics are the best practical electrode materials for number of electrochemical energy conversion devices, specially for fuel cells and batteries. This work is based on synthesising and electrically characterising binary oxide ceramics of LiFeO₂, LiCoO₂ and NiO, which are regarded as promising candidates for the cathode of the Molten Carbonate Fuel Cell (MCFC) and the Lithium Ion Battery (LIB). A number of new compositions under NiO-LiFeO₂, LiFeO₂-LiCoO₂ and LiCoO₂-NiO binary systems have been investigated. The feasibility of two wet-chemical techniques, the glycine-nitrate method and the Pechini method, was investigated in order to obtain powder with characteristics appropriate for cathode fabrication. Scanning Electron Microscopy was employed to investigate the powder morphology. The phase analysis on the materials was carried out with X-ray diffraction and the d.c. conductivity measurements were performed by the four-probe method from room temperature to 800 °C.

The powder prepared by Pechini method shows better characteristics of having rather spherical shaped agglomerated sub-micron size particles. The phase analysis reveals the existence of solid solution of *Fm3m* structure in LiFeO₂-NiO rich compositions. Increase of the LiCoO₂ content in the composition results in the formation of *R3m* layered structure of LiCoO₂. The electrical conductivity of the LiFeO₂-NiO and LiFeO₂-LiCoO₂ compositions lay between those of the end materials. However, a completely different behaviour is seen in LiCoO₂-NiO System, where the conductivity increases drastically to a maximum with the increase of LiCoO₂ content. These binary materials, specially the compositions up to 80 mole% of LiCoO₂, show promising characteristics for the MCFC cathode application, having adequate electrical conductivity (well above 1 S/cm at the operating temperature of 650°C). The LiCo_{0.2}Ni_{0.8}O₂ composition shows an electrical conductivity of about 0.01 S/cm at 25 °C in air, while it is about 0.001 S/cm of LiCo_{0.8}Ni_{0.2}O₂ composition. This significant room temperature conductivity together with the formation of LiCoO₂ type layered structure in these binary materials reveal their potentiality them for LIB cathode application.

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