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Synthesis and electrical characterisation of $Li(Ni_{1/3}Co_{1/3}Mn_{1/3})O_2$

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From an overall perspective Li-ion batteries undoubtedly represent the most promising energy storage system, and certain aspects of its principles of operation deserve particular attention. The performance of a battery is mainly related to the intrinsic property of the materials that form the positive and negative electrodes and the electrolyte. $LiCoO_2$ has most widely been used as the cathode material of Li-ion battery, however, the high cost of this material is a main obstacle for developing it as a cheaper and reliable potable power source. $Li(Ni_{1/3}Co_{1/3}Mn_{1/3})O_2$ has recently been investigated as a potential candidate for cathode material in secondary lithium batteries. With better cycling performance and stability at high potential windows, it is expected to perform better than the commercialised $LiCoO_2$. This paper presents a study of synthesis and electrical characterization of $Li(Ni_{1/3}Co_{1/3}Mn_{1/3})O_2$ material synthesised by Pechini method, which is a low cost technique but can result in powders with high purity, homogeneity and particle morphology that are highly desired for Li-ion battery cathodes.

$Li(Ni_{1/3}Co_{1/3}Mn_{1/3})O_2$ powders were synthesised by the Pechini method, with various ethylene glycol to citric acid (EG:CA) ratios of the organic precursor solutions, to investigate the affect of EG:CA ratio on the synthesised powder. The calcination studies were performed by calcining at 800 -1000 ^{0}C in order to find the optimum calcination temperature and phase analysis were performed by XRD. Under

electrical characterisations, the a.c. impedance, Seebeck and d.c. electrical conductivity (four probe method) analysis of sintered pellets were carried out.

The phase analysis revealed the formation of only the $Li(Ni_{1/3}Co_{1/3}Mn_{1/3})O_2$ phase of R3m structure in all the materials synthesised under different EG:CA ratios and calcination temperatures between 800-1000 °C, though the previous studies based on other synthesis techniques reported the lowest possible synthesis temperature as 900 °C. The electrical conductivity at 25 °C is about $1x10^{-4}$ S/cm and $2x10^{-3}$ S/cm at 200 °C, which are comparable with those reported from other studies where different synthesis techniques were employed. In an electrochemical performance study performed using the material calcined at 1000 °C, the cathode showed good reversible cycling behavior between 3.0 and 4.5 V and the discharge capacity observed is 175 mAh/g at room temperature, which is considerably higher than that reported for $LiCoO_2$ (138 mAh/g). Altogether, this study shows the ability of preparing $Li(Ni_{1/3}Co_{1/3}Mn_{1/3})O_2$ material by Pechini method, with appropriate electrochemical properties suitable for Li-ion battery cathode application.

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