**Ternary MnxNi1-xCo2O4 spinel oxides for oxygen reduction and supercapacitor applications; the role of carbon support and tunning metal compositions**

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Environment-friendly energy conversion and storage devices through the electrochemical processes have received extensive attention due to the common interests in the pursuit of a clean energy economy [1]. The development of efficient and low-cost electrocatalysts for using in these devices is imperative to achieve optimum use of renewable energy alternatives. Multimetallic oxides/carbon hybrid catalysts show excellent potentials in electrocatalysis, and they have been developed as alternatives for expensive and scarcer noble metals [2]. The multimetal oxides possess effective synergy between different metal elements, which are expected to promote electrocatalytic reactions [3].

In this study, a systematic investigation of ternary spinel oxides MnxNi1-xCo2O4 (x = 0, 0.3, 0.5, 0.7, and 1) was carried out to understand the effect of metal compositions and role of carbon support on the structural and electrocatalytic properties. The oxides were prepared using the citric acid-assisted sol-gel method followed by calcination under air. The lattice parameters were observed to vary with increasing values of x owing the substitution of Ni by Mn. After evaluating their oxygen reduction reaction (ORR) performance in alkaline media, Mn0.5Ni0.5Co2O4 was considered as an optimum composition and was supported on carbon nanosheets employing NaCl template and glucose as a carbon source followed by pyrolysis under an inert atmosphere. Cyclic voltammetry (CV) was used to screen out the oxygen reduction performance and Mn0.5Ni0.5Co2O4 was found to be the best performing electrocatalyst. Upon supporting the Mn0.5Ni0.5Co2O4 on a carbon sheet, the electrocatalytic activity was significantly enhanced owing to its large surface area and the improved charge transfer brought about by the carbon support. Rotating disk electrode studies show that the ORR activity of Mn0.5Ni0.5Co2O4/C proceeds via a four-electron pathway. Mn0.5Ni0.5Co2O4/C was found to possess E1/2(V) = 0.856, a current density of 5.54 mA cm-2, and a current loss of approximately 0.11% after 405 voltammetric scan cycles. This study suggests that the interesting electrocatalytic performance of multimetallic transition metal oxides can be further enhanced by supporting them on conductive carbon materials, which improve charge transfer and provide a more active surface area.

When tested as a supercapacitor electrode, Mn0.5Ni0.5Co2O4/C exhibited specific capacity of 91.2 mA h g-1 at a current density of 1 A g-1 in 2 M KOH. Moreover, after 3000 cycles the composite achieved a specific capacity of 74.6 mA h g-1 at a current density of 6 A g-1 and high capacitance retention of 96.4%.

 

Fig. 1: RDE curves comparison of MnxNi1-xCo2O4 in oxygen saturated 0.1 M KOH at 1600 rpm at cathodic sweep of 10 mVs-1 and plot of number of electrons transferred.

**References**

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