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Optimization of Ni:Mn compositional ratio in MCo_2O_4 (M=Ni and/or Mn) resulting in outstanding supercapacitors electrode material

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The fast-growing demand for eco-friendly, high power-density materials and devices has triggered significant research efforts. Generally, batteries are widely used for high energy-density applications like hybrid electric vehicles, power backup systems and computer backup. However, they have the limitations of high fabrication cost, low power density, limited cycle life etc. These limitations can be overcome by using supercapacitors which are ideal complementary storage devices since they have remarkable advantages such as high power density, long cycle life, fast charge/discharge capability, light weight, excellent reliability and flexibility [1-3]. However, in comparison to batteries they have low energy density. Hence, many efforts are being made to discover new materials and fabricate new supercapacitors with all the above mentioned advantages plus increased energy densities.

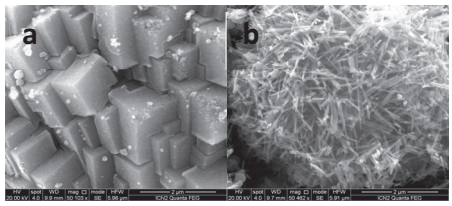

Figure 1: FE-SEM images of as synthesized $MnCo_2O_4$ (a) and $MnxNi_{1-x}Co_2O_4$ (b)

So far most of the research work is focused on redox-based electrode materials, including transition metal oxides and conducting polymers, because they exhibit much higher specific capacitances than carbon-based materials. Among them, hydrous RuO_2 has been extensively studied as a typical supercapacitor material due to its high specific capacitance (1580 F/g) and excellent reversibility with high reliability. However, its toxicity and high cost, prevent the realization of low-cost, high-performance electrode materials with more environmentally friendly and cost-effective properties.

The preparation of nanostructured hierarchical $Mn_xNi_{1-x}Co_2O_4$ metal oxides as efficient supercapacitors of different structures and configurations especially for the miniaturized electronics is still a challenge. In this context, we report template free facile hydrothermal synthesis of hierarchical nanostructured $Mn_xNi_{1-x}Co_2O_4$ with excellent supercapacitive performance. Significantly, the morphology of pure $MnCo_2O_4$ transformed from 3D microcubes to 1D nanowires with incorporation of Ni. The electrochemical studies show significant enhancement in supercapacitive properties of $MnCo_2O_4$ with the addition of Ni. Further, it is interesting to note, Ni doped samples show higher electrochemical performance than that of parent $MnCo_2O_4$ and $NiCo_2O_4$ samples. The highest specific capacitance of 2000 F/g and areal capacitance of 1.55 F/cm^2 were achieved for 60 % Ni doped $MnCo_2O_4$ sample. The high performance of the present hierarchical nanostructures can be attributed to the synergetic effect of morphology and chemical composition.

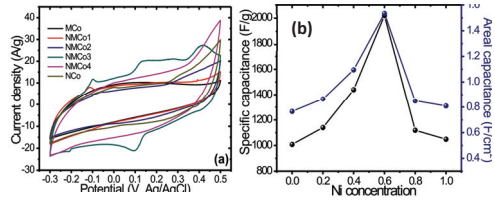

Figure 2: (a) Cyclic voltammetry (CV) measurements of MCo, NMCo1, NMCo2, NMCo3, NMCo4 and NCO within 0.50 V at a scan rate from 40 mV S^{-1} in 3.0M KOH electrolyte. (b) CV measurements ofNMCo3 sample at scan rate from 5 to 100 mV/s

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