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PII: S1385-8947(17)31893-4
DOI: https://doi.org/10.1016/j.cej.2017.10.169
Reference: CEJ 17953

To appear in: *Chemical Engineering Journal*

Received Date: 28 August 2017
Revised Date: 26 October 2017
Accepted Date: 30 October 2017

Please cite this article as: K.O. Oyedotun, M.J. Madito, D.Y. Momodu, A.A. Mirghni, T.M. Masikhwa, N. Manyala, Synthesis of ternary NiCo-MnO_2 nanocomposite and its application as a novel high energy supercapattery device, *Chemical Engineering Journal* (2017), doi: https://doi.org/10.1016/j.cej.2017.10.169

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Synthesis of ternary NiCo-MnO_2 nanocomposite and its application as a novel high energy supercapattery device

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ABSTRACT

NiCo /NiCoMn-mixed hydroxides and ternary NiCo-MnO_2 electrode materials were successfully synthesised by a force-driven hydrolysis of hydrated nickel, cobalt and manganese nitrate salts at 40 °C for 2 h with an additional annealing step adopted in producing the NiCo-MnO_2 sample. The morphological, structural, compositional and textural characterization of the samples were obtained using scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray powder diffraction (XRD), Raman spectroscopy, X-ray photoelectron spectroscopy (XPS), and N_2 physisorption respectively. The initial sample characterization confirmed bigger material agglomeration of the as-prepared mixed hydroxides compared to the NiCo-MnO_2 sample which had small stacked sheet-like and porous morphology. Further sample analysis also confirmed a high degree of crystallinity in both the mixed hydroxides and NiCo-MnO_2 samples with the elemental constituents existing in different oxidation states. One of the mixed hydroxides sample namely, $NiCo(OH)_2$ exhibited a specific surface area (SSA) of approximately 3.40 $m^2\ g^{-1}$ as compared to the ternary NiCo-MnO_2 material which exhibited a higher SSA of 153.94 $m^2\ g^{-1}$. The ternary NiCo-MnO_2 electrode exhibited the highest specific capacity of 132.1 mAh g^{-1}, compared to $NiCo(OH)_2$ and NiCoMn-triple hydroxide (NiCoMn-TH) electrodes which exhibited a specific capacities of 110.3 and 64.36 mAh g^{-1} respectively at a current density of 0.5 A g^{-1}. In addition, the ternary NiCo-MnO_2 electrode exhibited a better cycling stability compared to $NiCo(OH)_2$ electrode. Notably, an assembled NiCo-MnO_2//C-FP hybrid asymmetric supercapattery, displayed a specific capacitance of 130.67 F g^{-1}, high energy and power densities of 48.83 Wh kg^{-1} and 896.88 W kg^{-1} at 1 A g^{-1} respectively. An excellent cycling stability with a coulombic efficiency of 99.98% and capacitance retention of 96.78 % was recorded for up to 10,000 cycles within an operating voltage of 1.5 V, at a 3 A g^{-1} current density

KEYWORDS: Mixed hydroxides; NiCo-MnO_2; Carbonized iron cations (C-FP); Electrochemical performance; Supercapattery; Energy density.

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