**High-Performance Ni-Co-Al Layered Double Hydroxides for Advanced Pouch Cell Supercapacitors: Optimized Nanoarchitectures and Long-Term Stability**

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**INTRODUCTION**: In order to address global energy concerns and advance sustainable energy alternatives, it is imperative that high-performance energy storage technologies be developed[1]. Supercapacitors have become a viable option among energy storage technologies, helping to close the performance gap between batteries and traditional capacitors [2]. The flexible redox chemistry, high electrochemical activity, and structural stability of layered double hydroxides (LDHs), especially NiAl LDH and Ni-Co-Al LDH, have attracted a lot of interest.

**EXPERIMENTAL STUDY:** To optimize their nanoarchitectures for improved charge storage, we examine the electrochemical performance of NiAl LDH and Ni-Co-Al LDH that are manufactured using a controlled hydrothermal process. Cobalt improves electrochemical conductivity and speeds up redox transitions when added to the NiAl LDH matrix, both of which are essential for high-performance supercapacitor applications.

**RESULTS AND DISCUSSION:** The formation of distinct nanostructures with a high surface area and uniform distribution of metal cations is confirmed by thorough physicochemical and morphological characterizations using techniques such as X-ray diffraction (XRD), field-emission scanning electron microscopy (FESEM), transmission electron microscopy (TEM), and X-ray photoelectron spectroscopy (XPS). The superior performance of Ni-Co-Al LDH is demonstrated by electrochemical characterization using cyclic voltammetry (CV), galvanostatic charge-discharge (GCD), and electrochemical impedance spectroscopy (EIS). The hybrid supercapacitor pouch cell the achieves a high specific capacitance of roughly 210 F/g at a current density of 1 A/g. The improved energy storage properties are a result of the mixed-valence states increased ion transport and redox activity within the spinel-like structure. Additionally, the hydrogel-based electrolyte solution used in this investigation offers superior mechanical flexibility and ionic conductivity, guaranteeing steady cycling performance. After 20,000 charge-discharge cycles, the Ni-Co-Al LDH electrode maintains more than 92% of its initial capacitance, according to long-term stability testing, indicating its potential for useful supercapacitor applications.

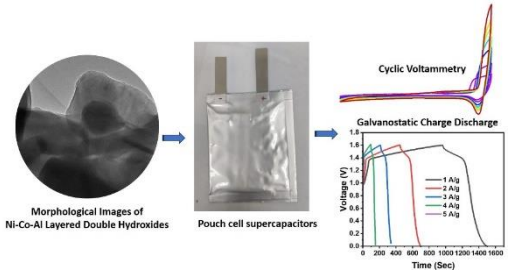


Fig. 1. The Schematic diagram of prepared material and fabricated pouch cells with corresponding electrochemical analysis.

**CONCLUSION:** These results witnessed the of NiAl LDH and Ni-Co-Al LDH as electrochemical properties. Ni-Co-Al LDH provides high energy storage capacity in pouch-type supercapacitor devices. This shows that the prepared Material is a potential candidate for supercapacitor applications.

***Keywords**:* Supercapacitor; Nano architectures; Layer double hydroxide; Electrochemistry.

**References:**

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