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Synthesis and Characterization of Bimetallic Fe-Co Metal Organic Framework

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ABSTRACT:

Improving supercapacitor technology—vital for the following wave of vigor loading plans— requires the growth of high-performance electrode materials. We tested the electrochemical performance of a synthesized Fe-Co metal organic framework MOF in a supercapacitor using the co-precipitation technique. The charge storage behavior is improved in the Fe-Co MOF as a consequence of the combined effects of cobalt's electrical conductivity and iron's redox activity. Electrochemical analysis employing cyclic voltammetry (CV), galvanostatic charge and discharge (GCD), and electrochemical impedance spectroscopy (EIS) corroborated the pseudocapacitive behaviour, which occurred at a current density of 0.3 Ag-1 and a high specific capacitance of 1312 F.g-1. A possible electrode material for high performance supercapacitors, the material has a low internal resistance and remarkable rate capabilities.

Introduction:

The demand of liveliness increases everyday with the passage of time. There's insufficient amount of energy that comes from nan renewable sources to full fill the requirements. Furthermore, non- renewable energy resources are limited and lead to significantly pollution in atmosphere. Analyzing the energy storage element is same as the power generating[1]. While batteries' high energy density makes them a great energy storage option, their low power densities, slow charge and discharge rates, and lackluster stability make them unsuitable for many uses. In fact, it's been thought of as a great option that calls for a power surge. This application is well-suited to supercapacitors because to their stability, high power density, and quick charging and discharging periods. This is why, out of all the energy storage technologies, a supercapacitor is the best option[2, 3]. Two types of supercapacitors exist, depending on how they store charge: pseudo- capacitors and electricity-powered double-layer capacitors. EDLC remains the carbon-based material that store charge electrostatically between two layers develop the boundary between electrode and electrolyte. Whereas conducting polymers and TMO based pseudo-capacitor employ the redox reaction to preserve charge faradaically[4, 5]

Scientist are working on novel materials with hierarchical layout and synergistic multi-metal design in an effort to get beyond this restriction. Metal organic framework (MOF) is now popular choice for following group vigor storing since of his huge surface area, tunable metal ligand chemistry and adjustable porosity[6]. MOFs can be used as precursor for porous carbon or metal oxide composite or as direct electrode material[7].

Recent research has shown that MOFs may be synthesized to exhibit electrochemical function, conductivity, and stability by meticulously choosing metal centers and organic linkers. Due to the limited redox-active sites of monometallic MOFs those containing a single type of metal ion frequently fails to achieve the optimal balance of electrochemical performance. To solution of this problem, bimetallic MOFs has been created in which two different metal ions are combine into a framework. This dual-metal technique enhances transportation properties of electron, metal stability and also increases the number of active sites through synergistic effects[8, 9].

Using the co-precipitation method, researchers looked at bimetallic Fe-Co MOF's possible so an conductor solid for high-presentation supercapacitors. The electrochemical behavior was systematically synthesized through EIS, CV and GCD.

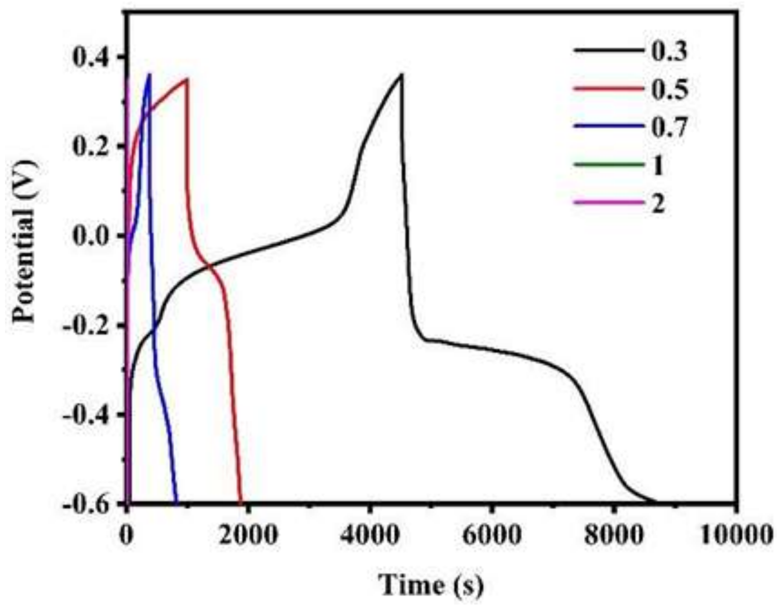
Fe-Co MOFs Synthesis:

Co-precipitation method is used to synthesized the sample. Firstly, dissolved the metal salts in solvent and then mixed with the organic linker. After allowing the mixture to sit for a few hours, it was washed and dried under intense heat to produce the powder.

Results And Discussion:

GCD remained employed to investigate the sample of electrochemical performance by changing the current densities. The specific capacitance in relation to various current densities is shown in Table 1. With respect to current density, figure 1 displays the GCD curves. Potential-time GCD curves exhibit non-linear behavior. Pseudocapacitive behavior of sample appear along the plateaus of curves.

At 0.3 Ag-1, the specific capacitance was 1312 Fg-1 within the possible region of -0.6 to 0.36V. Various image taxes are shown in table 1 together with the specified capacitance.



Fig#1: GCD at different scan rate Table 1: Specific Capacitance from GCD

Scan Rate (A/g)	Discharge Time	Specific Capacitance (F/g)
0.3	4200	1312
0.5	875	460.52
0.7	441.2	321.7
1	26.48	12.58
2	6.07	12.77

Using cyclic voltammetry, we examined the sample's behaviour at different scan speeds by comparing the current-potential plot within the same potential window. CV profiles at different

scan rate show in figure 2. Potential window for CV profile is -0.6 to 0.35V. Through polygon area under the curve, we calculate specific capacitance. A greater specific capacitance is associated with a larger area under the curve. Its larger polygon area causes its specific capacitance to be maximum at lower scan rates (see Figure 2). Various scan rates are shown in Table 2 for the specific capacitance of cyclic voltammetry.

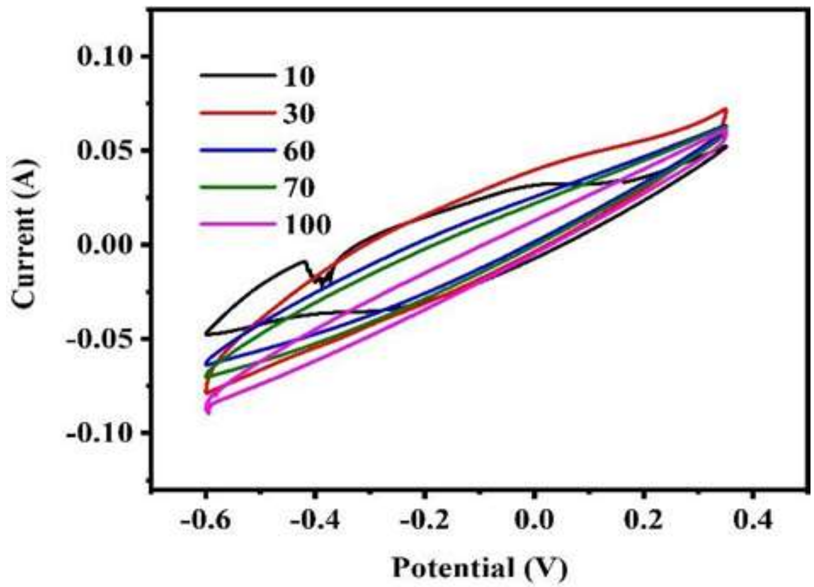


Fig #2: CV at various scan rate

Table 2: specific capacitance of CV

Scan Rate	**Specific Capacitance**
10	39.2
30	16.8
60	4.64
70	3.77
100	2.04

Conclusion:

Research in this area aimed to determine if a bimetallic iron-cobalt (Fe-Co) metal-organic framework (MOF) made via co-precipitation may be useful as an conductor solid for high- presentation supercapacitors. With iron's redox activity and cobalt's higher electrical conductivity, the electrochemical performance was boosted by the combined features of the two elements. Electrochemical techniques such as cyclic voltammetry (CV) and galvanostatic charge-discharge (GCD) tests confirmed the material's pseudocapacitive properties. At 0.3 A/g, the electrode displayed top-notch rate capability, little internal resistance, then a great exact capacitor of 1312 F/g. These results suggest that Fe-Co MOFs might be used as innovative conductor resources for vigor loading devices, which could result in more efficient and eco-friendly supercapacitor technologies.

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