Enhancing Sodium-Ion Batteries by Synthesizing a Novel Cathode Using Covalent Organic Frameworks Doped With Carbon Nanotubes

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Given the anticipated scarcity of lithium, there is a potential risk of inadequate supply for future lithium-ion batteries (LIBs). Sodium-ion batteries (SIBs) are promising alternatives to LIBs due to the abundance of elemental sodium. However, SIBs fail to meet the performance characteristics of LIBs due to the big size of sodium ions and the large molecular weight of the inorganic electrode materials. This research aims to develop new lightweight organic cathode material to enhance the rate performance, cycling stability, and specific capacity of SIBs. The new cathode material consists of a covalent organic framework (COF) called PDANDI doped with different carbon nanotubes (CNTs) percentages, 0% (pure PDANDI), 30%, 50%, and 100% (pure CNT). Following their fabrication, five batteries were fully characterized, and the performance of twelve batteries was evaluated via electrochemical analysis. It was found that PDANDI-50% CNT exhibits a specific capacity of 110mAh/g greater than the 71mAh/g, 67mAh/g, and 27 mAh/g of the PDANDI-30% CNT, PDANDI, and pure CNT batteries, respectively. Specifically, PDANDI-50% CNT demonstrates stability over 5000 cycles and an average discharge voltage of 2.1V, greater than the previously reported Aza-COF, which exhibits stability over 500 cycles with an average discharge voltage of 0.7V. Further, ex-situ Fourier transform infrared spectroscopy (FTIR) measurements showed the reaction mechanism of carbonyl bonds during charge and discharge processes. The fabrication of SIBs with COF-CNT-based cathode material is crucial for developing effective SIBs that can be utilized in stationary applications and energy storage systems to reduce reliance on LIBs.