Advanced energy storage applications using carbon nanomaterials and their derivatives

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Porous carbons are promising candidates for use as electrode materials of electrochemical capacitors due to their high electrical conductivity, chemical stability, and large specific surface area, necessary for enhancing the electrochemical performance. Especially, interconnected porous carbon nanosheets with desirable pore structure are highly recommended as electrode materials for advanced electrochemical capacitors because of their short diffusion lengths, high surface area, and low tendency for aggregation. In this presentation, we will introduce synthesis of interconnected porous carbon nanosheets by direct carbonization of organic salts and their electrochemical capacitor applications. Various redox active molecules can be also introduced to enhance the performance of carbon-based electrochemical capacitors.

Furthermore, we will introduce a new type of energy storage system called electrochemical flow capacitors (EFCs). The EFCs use a flow battery system design, however their charge storage mechanism is similar to that of electrochemical capacitors. The EFCs are highly promising for large-scale electrical energy storage because they have several key benefits derived from both electrochemical capacitors and flow batteries, such as the high power density, long cycle lifetime, and scalable energy capacity. In the EFCs, development of high-performance slurry electrodes which act as the active material for capacitive energy storage is one of the key technologies. Demonstration of the redox-active hydroquinone (HQ) molecules based aqueous redox flow capacitor will be presented in this talk.