Revisiting Supercapacitors with Hierarchical Porous Electrodes

Supercapacitors (SCs) are rapidly emerging as a new class of energy storage devices that can be used in a broad range of applications. SCs distinguish from lithium ion batteries by their ability to be charged and discharged at ultrafast rates. Carbon materials, owing to their excellent electrical conductivity, tailorability, inexpensiveness and versatility, have been extensively studied as electrode materials for SCs. The capacitance of carbon-based supercapacitor electrodes has remained at a mediocre level between 100 and 200 F/g for decades. Until recently, a new family of carbon materials termed hierarchical porous carbons has pushed the capacitance to new benchmark values beyond 300 F/g, and has revitalized the exploration of carbon materials for supercapacitors.

We have recently developed some hierarchical porous carbons contain different scales of pores inter-connected together and assembled in hierarchical patterns, through a combination of freeze drying, template, chemical etching and 3D printing. These porous carbons can be used not only as electric double layer materials that enable ultrafast charging/discharging, but also as current collectors to support pseudo-capacitive materials with ultrahigh mass loading. The findings pave a way for improving rate capability of supercapacitors and their capacitances at ultrahigh current densities and mass loadings, which are long-standing challenges for SCs.