Hypercrosslinked polymers as electrodes in enhanced structural composite supercapacitors

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Composite structural energy storage systems are capable of both carrying mechanical loads and storing electrochemical energy simultaneously. Highly sulfonated hypercrosslinked polymers (SHCPs) offer promising potential as electrode materials for energy storage systems. In this research, I investigate the impact of varying SHCP chemistry on the capacitance of structural energy storage devices by the introduction of tertiary amine moieties.

Here, I successfully synthesise three sulfonated hypercrosslinked porous polymers via a simple one-pot route[1] containing various concentrations of tertiary amine via the inclusion of triphenylamine as a monomer in SHCP synthesis. The introduction of tertiary amine groups was hypothesized to induce pseudocapacitance in energy storage devices and to improve their overall capacitance. Resulting SHCPs were characterised using various methods, including N_2 gas sorption isotherms, thermogravimetric analysis, and FTIR spectroscopy. The polymers exhibited large surface areas of up to 600 $m^2 \cdot g^{-1}$ and demonstrated outstanding chemical and thermal stability, underscoring their potential as highly desirable materials for energy storage applications.

For the manufacturing of structural supercapacitors, SHCPs were deposited onto CF from solution by either electrophoretic deposition or casting via doctor blade. Coated fibres were then assembled into devices[2] with either liquid or structural electrolyte matrices. Using cyclic voltammetry, specific capacitances of up to 3.1 $F \cdot g^{-1}$ and 3.5 $F \cdot g^{-1}$ were measured for liquid and structural composite supercapacitors, respectively, and pseudocapacitive behaviour was induced upon the incorporation of tertiary amines.

Keywords: hypercrosslinked polymers, composite materials, energy storage.

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