Natural Fiber Welding: The Preparation of Cotton-based Activated Carbon Electrodes

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This work describes a novel method for fabricating flexible and durable supercapacitor electrodes with ionic liquids. Ionic liquids (ILs) have been utilized as effective solvents for manipulating biopolymer matrices such as cellulose and silk.[1-4] In recent years, the De Long-Trulove research group has demonstrated a novel process for modifying natural materials called 'Natural Fiber Welding'. This process uses controlled amounts of ILs and molecular co-solvents to selectively swell and mobilize biopolymers in fibrous, natural materials for functional (chemical and physical) modification. In the current embodiment, we demonstrate the use of IL-based solvents with a small amount of solubilized biopolymers to embed activated carbon and as well as additional carbon nanomaterials into cotton yarn matrices. Modified yarns are subsequently utilized as electrode materials in knitted supercapacitors prepared and studied in a collaborative effort with Drexel University.

This presentation focuses on process variables that optimize composite electrode performance. In particular, mixture parameters such as the IL-based solvent composition, the ratio of cellulose binder to carbon, the composition of the carbon (i.e., activated carbon, carbon nanotube, and/or graphene) each impact the physical and chemical characteristics of coating 'inks' and, ultimately, electrode performance. Selected characterization data that detail the physical and chemical properties of these unique functional composite materials will be discussed.

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