Knitted electrochemical capacitors for applications in wearable electronics

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Flexible and wearable electronics are finding more applications in products for sports and healthcare, military technology, as well as safety and construction supplies. Some notable examples include, *Nike Fit, Addidas MiCoach, UnderArmour*, and *Google Glass*. However, these devices still use conventional pouch cell or hard batteries and electrochemical capacitors. Our previous work[1,2] focused on screen printing carbon materials into cotton, polyester and carbon fiber textiles, but suffer from delamination of carbon from the fiber surface. In this work we describe a knitted, all-solid supercapacitor based on carbon materials (e.g., activated carbon and graphene), which have been embedded into cotton yarns.

Carbon materials are introduced to cotton yarns using the processing method, 'Natural Fiber Welding,' by collaborators at the US Naval Academy. In short, the process utilizes ionic liquid-based solvents to partially embed carbon into the cotton fiber surface with minimal modification to the cellulose substrate. A small amount of solubilized cellulose increases the mechanical integrity of coatings to limit delamination from the cotton substrate.

These capacitive yarns, along with stainless steel yarn, act as the electrode and current collector, respectively. They are assembled on a Shima Seiki 3D knitting machine into 2-electrode symmetric supercapacitors as a single sheet of fabric and are coated in electrolyte. Rather than a liquid electrolyte, a PVA based gel electrolyte[3] is used to eliminate the possibility of leaking. In addition, our knitting equipment is industrial grade, meaning any devices we design can be sent to a factory and mass-produced.

We will discuss their electrochemical performance, reporting capacitance and series resistance from cyclic voltammetry, galvanostatic cycling and electrochemical impedance spectroscopy. We will also compare these textile supercapacitors to conventional non-flexible supercapacitors made of the same active carbon materials, as well as other textile devices described in literature[4-5].

References:

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