TEMPLATE-FREE SYNTHESIS OF POLYPYRROLE MICROTUBES

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Interest in new energy storage technologies, especially to support transportation and renewable energy generation, is increasing at a rapid rate. New technologies face many challenges, such as efficiency, charge storage capacity and long term cycle stability. Emerging devices, like supercapacitors, have the potential to provide high energy storage capacity and fast charge-discharge rates to bridge the gap between traditional batteries and high-power capacitors.

Many classes of materials can be used for supercapacitor electrodes, ranging from high surface area, inert carbon nanomaterials to Faradaic metal oxides and conducting polymers. Electroactive conductive polymers (ECPs) are promising materials, since they are conductive, possess moderate to high energy storage capacity, and can be synthesized using low cost and large scale methods.

In this work, we investigate a simple approach to growing large quantities of ECP microtubes without the need for a solution or substrate based template. Due to its relatively high specific power and energy, polypyrrole is used to synthesize electrodes comprising microtube structures. Polypyrrole was electrochemically polymerized on stainless steel mesh substrates (with varying wire diameters and spacing). The structure and electrochemical properties of microtube electrodes were studied to understand the growth mechanism and microtube formation, and how the electrode structure affects the charge storage properties.

Electrodes prepared on small mesh sizes (i.e. 200x200) exhibited a high density of microtubes with excellent electrochemical properties. We also demonstrated that this synthesis approach can be scaled up to large area substrates without any loss in electrode performance. Our results clearly demonstrate the effects of the substrate and current density on the template-free assembly and electrochemical performance of polypyrrole, as well as new ways to manipulate the physical structure of redox materials for supercapacitor electrodes. Importantly, this approach is amenable for large-scale synthesize of micro and nanostructured electrode systems.