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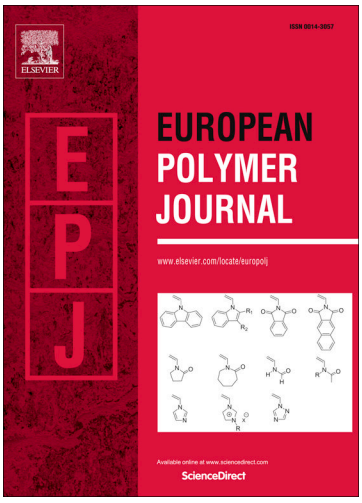

Facile synthesis of highly processable and water dispersible polypyrrole and poly(3,4-ethylenedioxythiophene) microspheres for enhanced supercapacitive performance

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Facile synthesis of highly processable and water dispersible polypyrrole and poly(3,4-ethylenedioxythiophene) microspheres for enhanced supercapacitive performance

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Much recent work has focused on improving the processibility and electrocapacitive performance of conducting polymer-based materials for energy related applications. The key mechanism of conducting polymers as supercapacitor materials as is driven by the rapid charging and discharging processes that involve mass transport of the counter ions insertion/ejection within the polymer structure, where ion diffusion is usually the limiting step on the efficiency of the conducting polymer capacitor. Here, we report a facile method for the green fabrication of polypyrrole microspheres (PPy-MSs) and poly (3, 4-ethylenedioxythiophene) microspheres (PEDOT-MSs) with good processability, intact morphology and large active surface for enhanced ion interchange processes, without using surfactant and highly irritant or toxic organic solvents during the synthetic process. The structure and morphology of the PPy-MSs and PEDOT-MSs were characterized by means of SEM, EDX, TEM and FTIR. Both PPy-MSs and PEDOT-MSs showed intact microsphere structures with greatly improved water dispersity and processability. More importantly, facilated by the large active surface and inter-microsphere space for ions diffusion, both the PPy-MSs and PEDOT-MSs showed a signiciantly enhanced electrical capacitive performance of 242 F g^{-1} and 91.2 F g^{-1}, repsectively (i.e. 10 and 1.51 times in specific capacitance than the randomly structured PPy and PEDOT). This innovative approach not only addresses fundamental issues in fabrication of high performance processable microstructured conducting polymers, but also makes progress in delivering water processable conducting polymers that could be potentially used for fabrication of printed electronic devices.

Keywords: energy materials, conducting polymers, microspheres interface, colloidal chemistry

Introduction

Intrinsically conductive polymers (ICP), a class of organic polymers that conduct electricity, were first reported by Hideki et al. in 1977 **[1]**. As one of the most fascinating functional/conducting materials, organic conducting polymers have attracted considerable attention in recent years due to their unique electrical and physicochemical properties, such as electrical conductivity, high biocompatibility, good chemical stability, high electron affinity, low ionization potential and low energy optical transitions **[2-9]**. Therefore, conducting polymers are widely use in solar cells **[10,11]**, supercapacitors **[12-16]**, drug delivery vehicles **[17-19]**, transparent conductive electrodes **[20,21]**, organic semiconductor **[22]** and sensors **[23,24]**. However, their performance in such applications are profoundly affected by the structural morphology of the conducting polymer. An appropriate micro/nanostructure could improve the material processability and increase the effective surface area for the ion insertion processes, and thus enhance the performance of conducting polymer devices, such as printed biosensors **[25]** and supercapacitor electrodes **[26]**. Various kinds of conducting polymer micro/nanostructures have been developed, such as microspheres **[27-33]**, nanofibers **[34, 35]**, nanotubes **[36]**, nanorods **[37,38]**, nanowires **[39]**, micro/nanoparticles**[40,41]** and microcapsules **[42-44]**. Among these micro/nanostructures, microspheres/particles have attracted special attention because of their spherical geometry, which minimizes surface energy thus reducing the aggregation effect, homogeneous distribution, and leads to easy processing into a colloidal suspension. In addition, microsphere particles are ideal building blocks for the construction of 2D or 3D devices incorporating hierarchical structured and processable materials for printed electronics **[45]**.

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