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POS-19 Carbon allotropes grafted with poly (pyrrole) derivatives via living radical polymerizations: electrochemical analysis of nano-composites for energy storage

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Carbon-based nanomaterials are key components in energy storage devices. Their functions can be tailored by adjusting or developing new synthesis pathways. In this study, two living radical polymerization techniques, an electrochemically-aided atom transfer radical polymerization (e-ATRP) and reversible addition chain transfer polymerization (RAFT), were applied for grafting of carbon allotropes such as multi-walled carbon nanotubes (MWCNT), graphene and single-walled carbon nanohorns (SWCNH) with a 2-(1H-pyrrol-1-yl)ethyl methacrylate. The functionalized carbons were examined as polymerization initiators in the RAFT and e-ATRP synthesis. The Fourier-transform infrared and Raman spectroscopies were used to identify the reaction products at each phase and for the final composites. TEM imaging showed that the morphology of composites made from the same carbon allotrope are not significantly different for RAFT and e-ATRP products; and the structure of the ultimate product strongly depends on the type of carbon. Also, the poly(pyrrole) film or the particle size was very small (in all cases less than 30 nm), demonstrating the control over the polymer morphology in living polymerization techniques. The high specific gravimetric capacitances over 456 F g-1 and electrochemical stability up to 7500 cycles were obtained for MWCNT-grafted-poly(pyrrole), and slightly less for Graphene-based composites synthetized by e-ATRP, showing the advantages of this method over RAFT. The electrode voltages for all composites were higher as compared to the pure polymer electrodes, with some benefit of RAFT over e-ATRP product, and with significant improvement observed for the MWCNT- and Graphene-based systems. Regardless of the synthesis method, all composites demonstrated enhanced specific capacitance as compared to their individual components, revealing the synergy of double-layer capacitance from the carbon and the pseudo-capacitance generated by the polymer fraction.

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