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Preparation and characterisation of conducting biopolymer-carbon nanotube composite materials

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Carbon nanotubes (CNTs) have unique electronic, mechanical, optical and thermal properties which make them interesting as a material for nanotechnology applications. However, the use of CNTs is limited due to their aggregation behaviour and insolubility in most common solvents. This poor process-ability is due to high surface energy and the extremely strong π and Van Der Waals interactions. Many different processing methods for fabrication of conducting CNT materials have been used including filtration, fiber spinning, inkjet printing and drop casting. Carrageenan is a generic name for the biopolymer family of water soluble, linear sulphonated galactans extracted from red seaweed which is known for their gel forming and thickening properties.

Homogenous CNT dispersions using Kappa-carrageenan (KC) as dispersant were prepared by sonication. The length of sonication required to disperse SWNTs and MWNTs in KC was optimized using UV-vis-NIR spectroscopy. Our results indicate that MWNTs require less sonication time compared to SWNTs, i.e. 20 minutes versus 35 minutes. Rheology results show that increasing the sonication time reduces the apparent viscosity of KC solutions, while addition of CNT increases viscosity significantly.

Free standing films were prepared by evaporative casting and vacuum filtration processes. The conductivity of MWNT composite films prepared by an evaporative casting process were similar compared to those of the SWNT composite films (7-9 S/cm). In contrast, the conductivity values of SWNTs composite films (25 S/cm) prepared by a vacuum filtration process were higher compared to those of the MWNTs composite films (16 S/cm). Addition of glycerin to these films reduced their conductivity, but increased their flexibility. Scanning electron microscopy revealed that the difference in conductivity is due to the biopolymer coverage of the CNT-CNT junctions in the CNT network. This work contributes to the development of conducting biopolymer composite materials.

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