More info & contact:
Technology Transfer Interface
R&D Department
Hugo Loosvelt
[T]: +32 (0)2 629 38 65 or 22 07
[E]: hloosvel@vub.ac.be
[W]: www.vubtechtransfer.be

Carbon Nanotube Copolymer Composites for use in Conductive and Semi-Conductor Applications

Summary

Carbon nanotubes (CNT's) are finding varied uses as fillers for composite materials for use in electrically conductive films, electrostatic coatings and enhancements to physical strength. The price of CNT's has fallen over the last few years and the price varies with quality, purity, quantity, size, functionalization and presentation. For MWCNT's the price varies from $5 to $25 per gram, for SWCNT's $45 to $300 per gram. Although costs are expected to reduce further in future, there is a huge financial incentive to reduce CNT loadings for conductive materials.

Carbon nanotubes are sold either as masterbatch solutions or as bundled dried tubes for health and safety reasons. One of the greatest problems with these materials is ensuring that the CNT's are exfoliated and that they connect within the polymer matrix (percolate). The less CNT's required for percolation (electrical conductivity), the lower the costs will be and the better the optical properties of the polymeric materials should be.

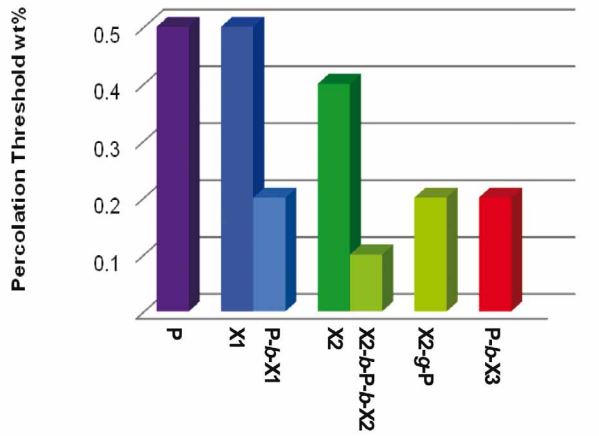
The block copolymers developed within FYSC (Department of Physical Chemistry and Polymer Science) are produced using aqueous emulsion and dispersion techniques offering a controlled and facile route to polymer synthesis and composite materials. Composites are prepared by either mixing pre-exfoliated CNT solutions (current technology) or by directly dispersing/exfoliating CNT's into the concentrated aqueous polymer solutions (improved methodology.)

Application of Technology

1) Exfoliation of CNT's into dilute polymer solutions to create masterbatches
2) Direct dispersion of CNT's into concentrated polymer batches
3) Polymer dispersions can be used for conductive coatings
4) Flexible methods of application and wide range of substrates
5) Use in conductive inks
6) Easy preparation of conductive thin films (40 µm to 500 µm)
7) Co-polymers can be tailored to contain a wide variety of polymers with interesting properties
8) Materials are easy to modify
9) Future uses in solar cell applications, plastic wires, synthetic tissue engineering, sheet printed circuit boards and flexible electrodes
10) A future beyond CNT's – systems can be used for preparation and dispersion of graphene, or metallic nanowires

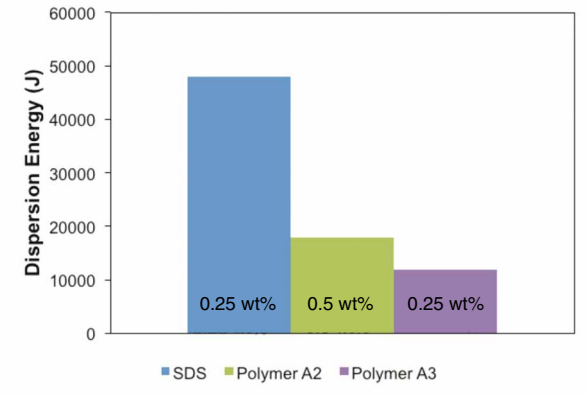
Innovation Advantages

1) Improved efficiency in exfoliation of MWCNT's without SDS or volatile organic compounds. SDS has a detrimental effect on nanotube/matrix compatibility.
2) Dilute copolymer solutions are weight for weight better than SDS in terms of energy required and in terms of no. of moles of surfactant requires 175x less. Less energy means less risk of CNT's damage or deformation.
3) Exfoliated CNT's within the polymer will have a higher compatibility with other polymer systems than SDS.
4) Copolymer can accommodate up to 20 wt% of filler.
5) By direct dispersal of CNT's into the polymer mixture, the need for pre-exfoliation of CNT's is removed. Full exfoliation may not occur in these samples, however, current studies suggest that some aggregation of CNT's can improve conductive qualities, this method allows for adjustment of degree of exfoliation.
6) From an aqueous mixture we can prepare films, inks, coatings that show conductive properties and are compatible with several substrates that include glass, aluminium, stainless steel, polycarbonate, nylon 6 and paper.
7) This polymer produces composites at lower weight% MWCNT's than most other polymer systems (4x lower than homopolymers) and with much thinner films.
See figure below.
8) The functionality of the polymers themselves can be altered to cause changes in thermal behavior, surface compatibility, or chain extension.



Status of Invention

Work is continuing into the physical characteristics of these materials and their applications. The main focus has been on testing these materials as free standing thin films and coatings on glass and on how low we can detect conductivity. So far percolation thresholds for multi-walled carbon nanotube composite materials are 4x lower than for polystyrene and poly(methyl methacrylate) composites.



IP Status

Copolymers and Their Use in Carbon Nanotubes' exfoliation, Dispersion and Conductivity.
Patent Application filed under:
US 61/485461 on 15/5/2011 and EP11184900.6 on 12/10/2011.

Collaboration

We are looking for interested parties to license and develop this technology further or test these materials.