Carbon Nanotubes - Polymer Composites for Improved Mechanical and Electrical Properties

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Principal investigator

Boris Rybtchinski

Faculty of Chemistry
Department of Molecular Chemistry and Materials Science

Overview

The superior mechanical and electrical properties of carbon nanotubes (CNTs) are uniquely advantageous for enhancing polymer composites' mechanical and electrical properties. However, CNTs usually heavily bundle. Their bundling impedes their liquid and polymer media dispersion and limits composite materials fabrication. Prof. Rybtchinski and his team have developed a new method for non-covalently modulating the CNT and creating stable dispersions, which enables the fabrication of novel polymer composites with improved mechanical and/or electrical properties.

The Need

Markets continuously search for stronger, more durable, lightweight, conductive, and cost-effective composites for various applications and industries. CNTs can enormously improve the properties of many materials, including polymer composites. CNTs, both single-walled (SWCNT â€“ a nanotube that is made from a single rolled graphene sheet) and multi-walled (MWCNTs â€“ a nanotube that is made from several rolled graphene sheets) become readily available and inexpensive due to recent large-scale production. However, CNTs have a high tendency for bundling, which impedes their dispersion in liquid (solvents) and solid (polymer) media. This issue is a central challenge as it limits the ability to fabricate materials with improved properties conveniently and cost-efficiently. Therefore, there is a need for a novel method to effectively disperse CNTs for the efficient fabrication of novel CNT/Polymer composites.

The Solution

Prof. Rybchinski and his team developed non-covalent hybrids comprising carbon nanotubes (CNTs) and small aromatic compounds that modify CNTs for efficient and stable dispersions in various solvents, solvent-mixtures, and polymers. The dispersions are simple to manufacture, environmentally friendly, and cost-effective.

Technology Essence

Non-covalent molecular attachment to CNTs has become a preferred approach for overcoming the dominant tendency of CNTs to aggregate since it does not harm the mechanical and electrical properties of CNTs, and it alleviates the need for additional regulations. The current technology utilizes physical interactions between small dye molecules to enhance the dispersibility of CNTs while maintaining their electrical properties and mechanical integrity. These novel dispersions enable an efficient CNT incorporation into polymer-based composites using several processing methods, including coating, filtration, casting, molding, extrusion, and injection. The aromatic compounds within the hybrids modify the surface energy of the adsorbing nanotubes for improved solution dispersibility and adhesion.

Applications and Advantages

Applications

- Lightweight structural and/or conductive components for automotive, aerospace, and energy industries
- Anti-static packaging and Electronics
- Electromagnetic interference (EMI) shielding and charge dissipation
- Electro-chemical devices such as circular voltammetry, sensors, and electrolysis
- Fabric, textile, paper, and elastomer (e.g., latex, rubber, polyurethane, silicone)
- Surface protection from humidity and liquid water

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Advantages

- Superior mechanical and electrical properties
- Cost-effective solution
- Non-toxic and environmentally friendly
- Maintains conductivity upon stretching or inflation of the material
- Improves spraying, filtration, and printing properties

Development Status

The group developed a novel method for the physical attachment of common inexpensive organic aromatic molecules to carbon nanotubes and provided compelling evidence for its successful incorporation with several polymers.

Patent Status

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