הטכניון - מכון טכנולוגי לישראל

TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

הפקולטה להנדסה כימית
ע״ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar

Monday, February 17th, 2025, at 13:30
Room 6

A Nanostractural Study of Carbon and Boron Nitride Nanotubes Processed into Macroscopic Fibers

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Ph.D. Seminar

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Carbon nanotubes (CNTs) and boron nitride nanotubes (BNNTs) are highly promising materials for nanotechnology applications due to their extraordinary properties. CNTs combine low density with exceptional mechanical strength, high melting temperature, and excellent thermal conductivity. Depending on their structure, they can be conductors or semiconductors. Similarly, BNNTs exhibit low density and remarkable mechanical and thermal properties, while also offering superior thermal stability and electrical insulation. These unique features have driven significant efforts to utilize CNTs and BNNTs in a wide range of applications. However, translating the extraordinary properties of the individual nanotubes into macroscopic nanotube-based materials remains challenging.

The wet-spinning method is a promising approach for producing high-quality nanotube-based macroscopic structures. This method involves the processing of a stable nanotube solution into highly aligned multifunctional fibers. Using the powerful chlorosulfonic acid (CSA), we spontaneously dissolve the nanotubes, while preserving their intrinsic properties, such as length and sp^2 hybridization. In the solution, the nanotubes exhibit lyotropic liquid crystallinity, with phase behavior dictated by nanotube concentration. At high concentrations, the nanotubes align into an ordered nematic liquid crystalline phase, which is ideal for liquid processing of neat, dense, and highly ordered fibers.

In this research, we have studied the liquid-phase processing of CNTs and BNNTs across all process stages, from synthesis and purification, through dissolution and liquid crystal formation, to fiber assembly. Each system presents unique challenges that we addressed by various advanced electron microscopy techniques. In particular, we employed cryogenic electron microscopy methodologies, which were modified to allow the observation of extreme systems such as the CSA. Our findings contribute to optimizing the fiber production process and enhancing its performance.

Refreshments will be served at 13:15