Nanotube Superfiber Materials: Chapter 13. Carbon Nanotube Sheet: Processing, Characterization and Applications (Micro and Nano Technologies)

Rachit Malik, Noe Alvarez, Mark Haase, Brad Ruff, Yi Song, Bolaji Suberu, Duke Shereen, David Mast, Andrew Gilpin, Mark Schulz, Vesselin Shanov

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Individual carbon nanotubes (CNTs) have exceptional mechanical and electrical properties. However, the transfer of these extraordinary qualities into CNT products, without compromising performance, remains a challenge. This chapter presents an overview of the manufacturing of CNT sheets and buckypaper and also describes research performed at the University of Cincinnati in this field. CNT arrays were grown using the chemical vapor deposition method. Sheets were drawn from the spinnable CNT arrays and characterized using scanning electron microscopy to show the highly unidirectional alignment of the nanotubes in the sheet. The anisotropic morphology of the sheet provides superior properties along one material axis as observed by measuring the tensile strength, electrical resistivity, optical transmittance, and electromagnetic interference shielding properties of the material. Surface modification of aligned multiwall nanotube sheets was carried out via incorporation of an atmospheric pressure plasma jet in the sheet posttreatment process. Helium/oxygen plasma was utilized to produce carboxyl (–COO–) functionality on the surface of the nanotubes. X-ray photoelectron spectroscopy confirmed the presence of the functional groups on the nanotube surface. The sheet was further characterized using Raman spectroscopy, Fourier transform infrared spectroscopy, and contact angle testing. Composite laminates made from functionalized CNT sheets showed higher strength than those made with pristine sheets. The effects of plasma power and oxygen concentration were studied in order to determine the best possible parameters for functionalization. Plasma treatment is a useful tool for fast, clean and dry functionalization of CNTs. This study demonstrates the ease of incorporating the plasma tool in the manufacturing process of sheets leading to the production of CNT/polymer composites. Macroscopic structures of nanotubes such as threads and sheets are leading to novel applications.

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