CARBON NANOTUBES

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ABSTRACT

The global business interest in carbon nanotubes (CNTs) is expressed in a capability of manufacturing that currently exceeds several thousand tonnes per year. Bulk CNT powders are currently integrated into a variety of business products ranging from rechargeable batteries, automotive components, and sports goods to hulls of boats and water filters. Advances in CNT synthesis, purification, and chemical modification enable CNTs to be integrated into thin-film electronics and large-scale coatings. Although for many apps, CNT yarns and sheets do not yet provide convincing mechanical strength or electrical or thermal conductivity, they already offer promising efficiency for apps including lightweight electromagnetic shields, supercapacitors and actuators.

Key words: Carbon nanotubes, electromagnet, efficiency.

INTRODUCTION

Carbon nanotubes (CNTs) are single-wall, SWNT or multi-wall, MWNT seamless cylinders with open or closed ends[1]. Perfect CNTs have all carbons bonded in a hexagonal lattice except at their ends, whereas failures in mass-produced CNTs introduce pentagons, heptagons and other imperfections in the sidewalls that usually degrade required characteristics. Most of today's CNT manufacturing is used in bulk composite materials and thin films that depend on restricted characteristics of unorganized CNT architecture. Organized CNT architectures such as vertically aligned trees, yarns and sheets show promise to increase the characteristics of individual CNTs and to recognize fresh functionalities, including restoration of form, thermoacoustic sound emission, terahertz polarization, dry adhesion, elevated damping, large-stroke actuation and near-ideal black-body absorption.

CNT Synthesis and Processing

Chemical vapor deposition (CVD)[2] is the dominant mode of high-volume CNT production and typically uses fluidized bed reactors that allow uniform gas diffusion and heat transfer to nanoparticles of the metal catalyst. Scale-up, use of low-cost feedstocks, increase in yields, and decrease in energy consumption and waste manufacturing have significantly reduced MWNT rates. Large-scale CVD techniques, however, produce contaminants that can affect CNT characteristics and often involve expensive heat annealing and/or chemical therapy to remove them. In CNT sidewalls, these steps can create flaws and shorten the duration of CNT.

Composite Materials

MWNTs were first used in plastics as electrically conductive fillers, using their high aspect ratio to form a percolation network at levels as small as 0.01 percent (wt. percent). Disordered composites[3] of MWNT polymer achieve conductivities of up to 10,000 S m–1 at 10 wt. percent load. Conductive CNT plastics have allowed electrostatic painting in the automotive industry, made it possible to paint mirror housings electrostatically as well as fuel lines and filters that dissipate electrostatic charges.

Coatings and Films

CNTs are emerging as a multifunctional coating material, leveraging CNT dispersion, functionalization, and large-area deposition methods. MWNT-containing paints, for instance, decrease ship hull biofouling by discouraging algae and barnacles attachment. CNT-based transparent films[4] continue to develop widely as an option to indium tin oxide (ITO). One problem is that because of the scarcity of indium, ITO is becoming more costly, compounded by increasing demand for screens, touch screens and photovoltaics.

Microelectronics

Due to their small electron scattering and their bandgap, which depends on diameter and chiral angle, high-quality SWNTs are appealing to transistors. SWNTs are also compatible with architectures for field effect transistors (FET) and high-k dielectrics[5].

CONCLUSION

CNT powders dispersed in polymer matrices or deposited as thin films are incorporated in most products using CNTs today. Organized CNT materials like trees and yarns are starting to bridge the gap between CNT's nanoscale characteristics and mass engineering materials ' long scales. However, it is necessary to understand why the properties of CNT yarns and sheets, such as thermal conductivity and mechanical strength, remain far below the properties of individual CNTs. CNTs science and applications, ranging from surface chemistry to large-scale production, will lead for many years to come to the frontier of nanotechnology and associated business products.

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