Review Article

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Carbon Nanotubes Properties and Applications

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Abstract
Nanotubes have never ceased to make object of research around the world. The scientific community has high hopes on these nanomaterials seen their exceptional properties and their various applications. They are so successful is because they have properties unsurpassed in many areas. They have excellent properties which can be used in many applications extending from macroscopic to nano composite materials. Here we present an overview of the different properties of these nanomaterials and their applications.

1. Introduction
Carbon nanotubes were discovered in 1991 by Professor Iojima, laboratories NEC, by using advanced electron microscopy techniques, nanotubes, have been constantly be research around the world, because their unsurpassed properties offer many applications [1]. The scientific community already based on high hopes for these nanomaterials to share their exceptional intrinsic properties, they will pave the way for a new industrial revolution already named by journalists as "nano revolution".

Carbon nanotubes (CNTs) present one of the first commercial applications of nanotechnology revolution. Since the development of these nano-objects, there are considerable interest given their exceptional intrinsic properties and characteristics dimensionnelles. These nanotubes have a particular crystalline structure, tubular, hollow and close, composed of atoms arranged in a regular pentagons, hexagons and/or heptagons, obtained from some materials, particularly carbon and boron nitride. They exist two types of carbon nanotubes: Single Wall Carbon Nanotubes (SWNTs) and Multi Wall Carbon Nanotubes (MWNTs), the MWCNTs consist of several graphene sheets rolled concentrically spaced about 0.33 nm [2,3]. MWCNTs diameter varies according to the number of sheets, of 1.3 nm to 100 nm and their lengths can reach μm. For (SWNTs) mono sheets, their structure may be represented by a graphene sheet wound on itself and closed at both ends by a hemisphere.

The diameter (SWNTs) may vary frome 0,7 nm to 2 nm or more depending on the synthesis method used, the length may reach about several micrometers or even several centimeters. The graphene sheets is folded over itself defines a parameter called helicity or chirality, which determines the structure of the SWNTs.Chirality can characterize various types of existing and SWCNTs can be represented by a vector whose coordinates are shown as n and m. The graphene sheets form a nanotube when wound so that the origin (0, 0) and the point (n, m) overlap. a_1 and a_2 are the unit vectors of the network and θ (a_1, a_2) represents the chirality angle (θ between 0 and 30°), that SWCNTs classify into three main families: the zigzag nanotubes (θ =0°, m or n = 0), the armchair nanotubes (θ = 30°, m = n) and chiral nanotubes (0 <θ <30° or m ≠ n ≠ 0) [4].

About the prospects of application, they are used in electronics (transistors, diodes), biology or chemistry even for storage of molecules and many other applications [5]. For the properties of these nanomaterials, they have properties unmatched in several areas, such as electrical properties, mechanical, chemical, thermal and several of other properties.

2. Properties and Application of Carbon Nanotubes
2.1. Electronic Properties and Applications
The electronic properties are mainly related to two integers n and m that define the helicity of the tube and its diameter. Theoretical calculations on infinite tubes are used to identify the three following cases: The Configuration armchair nanotubes (n, n) are Metal, also the Tubes (n, m) with multiple of 3 not null n-m are semiconductors low gap, also Other nanotubes are semiconducting or insulating wide gap. Usually, it is considered that the nanotube configuration (n, m) are metallic if n-m is a multiple of 3, in the contrary case, they are semiconductors.

For application: Among the applications of carbon nanotubes in microelectronics: Connectors, Diodes, A single electron transistor, Field Effect Transistor and Logic Gates (the basic components of a computer).

2.2. Mechanical Properties and Applications
Young's Modulus: theoretical value of 1 TPa. also measured values between 0.8 and 5 TPa, steel more resistant 0.2 TPa, Poisson ratio: 0.261 and very great elasticity, makes the most of reversible deformations, use as fiber reinforcement: Withstand high compression and Increase the hardness of the composite by absorbing energy (but some technical difficulties) [6].

2.3. Field Emission Properties and Applications

Principles of the field emission electron emitting for nanotube is to extract electrons from a metal tip tunneling by applying an electric field under vacuum. The material used for the transmission should have a lower emission threshold and a guarantee of high density and stable emission current, so:

- The dimensions of the nanotube, its perfect structure, high electrical conductivity and good chemical stability make it an ideal candidate.
- Has a low emission at room temperature and high current density depending on the type of nanotube threshold (mono or multi-wall nanotubes, with or without fault, or not open at one end).

For application: Issuance of individual nanotubes, luminescent elements, flat screen and X-ray tubes.

2.4. Electrochemical Properties and Applications

Large accessible surface of the nanotubes combined with good conductivity and high strength nanotubes make the attractive for making electrodes for electrochemical devices. For application: Ultracapacitors, electromechanical actuators, lithium batteries, Nanosensors and nanoprobes: Tips for near-field microscope dimensions and properties of a nanotube makes it an ideal candidate to be used as nano-point in: A tunneling microscopes (STM), Atomic force microscope (AFM) and electrostatic force microscopes. The nanotubes may be used for detecting small concentrations of gas molecules, with high sensitivity at room temperature for example: The agricultural medical applications, Detection of NO2 is used to measure environmental pollution resulting from combustion and auto emissions. NH3 detection is useful for medical industries and living environments (cells).

2.5. Chemical Properties and Application

Filling molecules or solid, training with supramolecular organization of molecules having properties of surfactants (SDS, lipids...), The Chemical grafting, of Syntheses of compounds such as nanorods GaN gallium nitride or silicon nitride Si3N4, or nanowires containment by reactions in the nanotubes and Train Heterogeneous catalysts.

2.6. Thermal Properties and Application

The tangential thermal conductivity of graphite is 3000 Wm-1 K-1. Measures led to values from longitudinal thermal conductivity 1800-6000 W.m1.K-1 for a single bundle and at room temperature A value of 6600 Wm-1.K-1 was obtained for a nanotube (10, 10) and isolated at room temperature. Also a value of 6600 Wm-1.K-1 was obtained for a nanotube (10, 10) and isolated at room temperature. For application: Nanotubes may significantly increase the thermal conductivity of the composite staple fiber.

2.7. Optical Properties and Application

Nanotubes Possess optical limiting properties in a wide range of wavelengths from the visible to near infrared. Low levels of nonlinearity and high optical densities were obtained from the study of aqueous dispersions of monolayer nanotubes. Performance equal or surpass those of other good optical limiters, such as C_{60} or carbon black, either in the visible or near infrared. For application: Design of protection systems for the eye and optical sensors because of intense laser sources. Using Nanotubes as infrared detector.

3. Conclusion

If carbon nanotubes are so successful is because they have properties unsurpassed in many areas.

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