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Structural Analysis of Nanomaterials and Nanoscale Devices

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ABSTRACT

Nanomaterials have been utilized for quite a long time in applications going from window glass and shades to auto guards and paints. Presently, be that as it may, the meeting of logical orders (science, science, gadgets, material science, building and so on.) is prompting an increase of utilizations in materials producing, PC chips, therapeutic determination and medicinal services, vitality, biotechnology, space investigation, security et cetera. Subsequently, nanotechnology is relied upon to significantly affect our economy and society inside the following 10 to 15 years, developing in significance over the more extended term as further logical and innovation leaps forward are accomplished.

Keywords: nanoscale, structural, devices, analysis.

INTRODUCTION

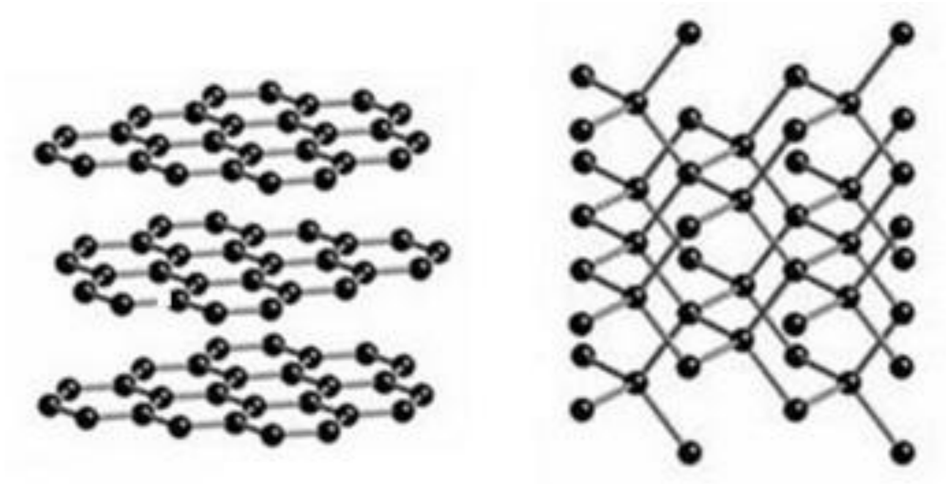
Nanotechnology ("nanotech") is control of issue on a nuclear, sub-atomic, and supramolecular scale. The most punctual, broad depiction of nanotechnology referred to the specific mechanical objective of exactly controlling particles and atoms for manufacture of macroscale items, additionally now referred to as sub-atomic nanotechnology. A more summed up portrayal of nanotechnology was along these lines set up by the National Nanotechnology Initiative, which characterizes nanotechnology as the control of issue with no less than one measurement estimated from 1 to 100 nanometers. This definition mirrors the way that quantum mechanical impacts are vital at this quantum-domain scale, thus the definition moved from a specific innovative objective to an examination class comprehensive of a wide range of research and advances that arrangement with the unique properties of issue which happen beneath the given size edge. It is thusly basic to see the plural frame "nanotechnologies" and in addition "nanoscale advances" to allude to the expansive scope of research and applications whose normal quality is estimate. As a result of the assortment of potential applications (counting mechanical and military), governments have put billions of dollars in nanotechnology inquire about. Until 2012, through its National Nanotechnology Initiative, the USA has contributed 3.7 billion dollars, the European Union has contributed 1.2 billion and Japan 750 million dollars.

Nanotechnology as characterized by estimate is normally extremely expansive, including fields of science as differing as surface science, natural science, atomic science, semiconductor material science, microfabrication, sub-atomic building, etc.[4]. The related research and applications are similarly different, going from augmentations of traditional gadget physical science to totally new methodologies in view of sub-atomic self-gathering, from growing new materials with measurements on the nanoscale to coordinate control of issue on the nuclear scale.

Nanotechnology might have the capacity to make numerous new materials and gadgets with an immense scope of utilizations, for example, in nanomedicine, nanoelectronics, biomaterials vitality generation, and buyer items. Then again, nanotechnology raises a large number of an indistinguishable issues from any new innovation, including worries about the poisonous quality and ecological effect of nanomaterials and their potential consequences for worldwide financial matters, and also theory about different doomsday situations. These worries have prompted a verbal confrontation among backing gatherings and governments on whether exceptional control of nanotechnology is justified. Nanotechnology could affect the creation of for all intents and purposes each human-made question – from autos and hardware to cutting edge diagnostics, surgery, propelled drugs, and tissue and bone substitutions.

STRUCTURE ANALYSIS OF NANOMATERIALS

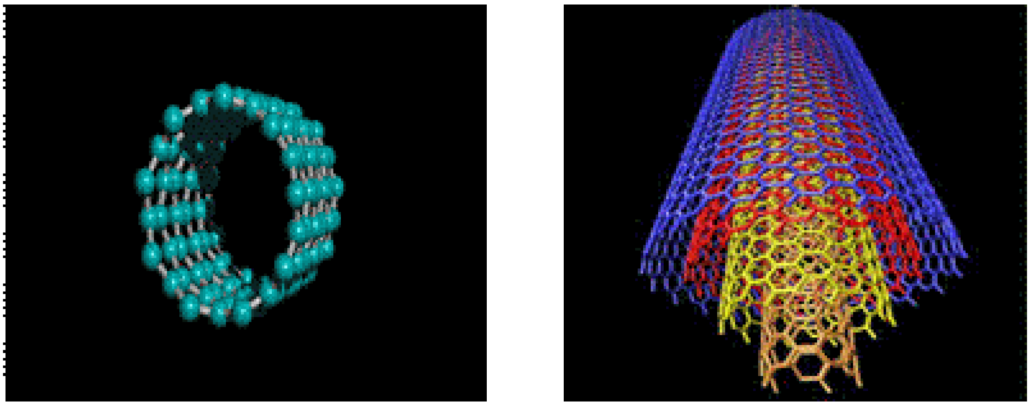
Carbon nanotubes (CNTs) are considered as a new form of pure carbon. The pure carbons only have two types of covalent bonding; sp2 and sp3 hybridizations that dominate in graphite and diamond, respectively. The structure of graphite and diamond are shown in Fig. 1.



(a) (b)

Fig. 1: The structure of graphite (a) and diamond (b)

Carbon nanotubes (CNTs) are cylinder-shaped macromolecules with a radius as small as a few nanometers, which can be grown up to 20 cm in length. The walls of these tubes are made up from a hexagonal lattice of carbon atoms analogous to the atomic planes of graphite. They are capped at their ends by one half of a fullerene-like molecule. Two types of carbon nanotubes exist in nature: single-walled carbon nanotube (SWNT) and multi-walled nanotube (MWNT) as shown in Fig. 2.



(a) (b)

Fig. 2: The structure of open-end single-walled carbon nanotube (a) and multi-walled carbon nanotube (b)

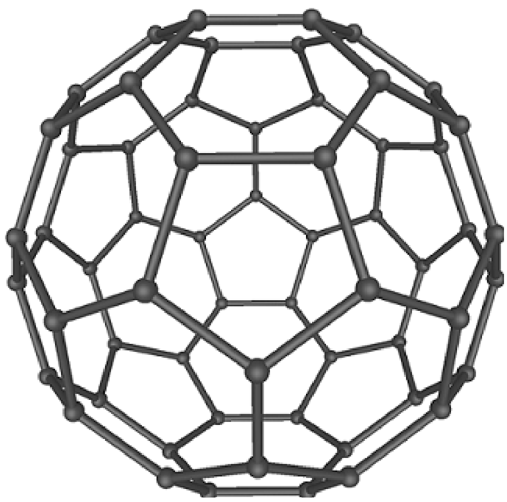


Fig. 3: Carbon structures of C60 also known as fullerenes

From theoretical studies on the electronic properties of SWNT it was shown that all armchair tubules are metallic, as well as zigzag cylinders exhibiting values of m and n in a multiple of three. In summary, the metallic transport condition for these tubular structures can be expressed as

$$(2m+n)/3 = \text{integer}$$

Carbon nanotubes also possess the unique properties for examples, chemical and thermal stability, extremely high tensile strength and elasticity, and high conductivity etc. In details, carbon nanotubes are the strongest fibers ever known. A SWNT can be up to 100 times stronger than that of steel with the same weight. The Young's Modulus of SWNT is up to 1TPa, which is 5 times greater than steel (230 GPa) while the density is only 1.3 g/cm3 and the thermal conductivity (2000 W/m.K) is five times greater than that of copper (400 W/m.K).

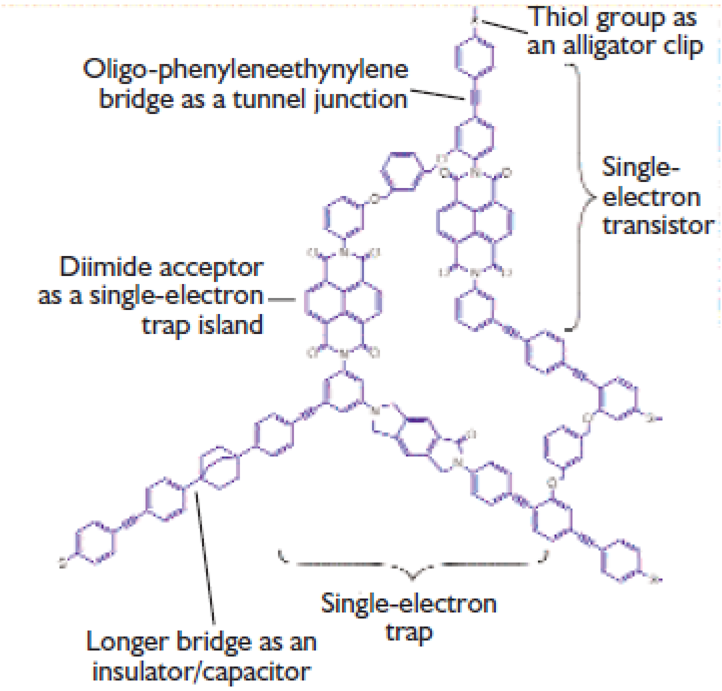


Fig. 4: Structure of Gold nanowire

Comparison of Nanoscale Sizes

Inspired by Feynman's concepts, K. Eric Drexler used the term "nanotechnology" in his 1986 book Engines of Creation: The Coming Era of Nanotechnology, which proposed the idea of a nanoscale "assembler" which would be able to build a copy of itself and of other items of arbitrary complexity with atomic control. Also in 1986, Drexler co-founded The Foresight Institute (with which he is no longer affiliated) to help increase public awareness and understanding of nanotechnology concepts and implications.

Thus, emergence of nanotechnology as a field in the 1980s occurred through convergence of Drexler's theoretical and public work, which developed and popularized a conceptual framework for nanotechnology, and high-visibility experimental advances that drew additional wide-scale attention to the prospects of atomic control of matter. In the 1980s, two major breakthroughs sparked the growth of nanotechnology in modern era.

First, the invention of the scanning tunneling microscope in 1981 which provided unprecedented visualization of individual atoms and bonds, and was successfully used to manipulate individual atoms in 1989. The microscope's developers Gerd Binnig and Heinrich Rohrer at IBM Zurich Research Laboratory received a Nobel Prize in Physics in 1986. Binnig, Quate and Gerber also invented the analogous atomic force microscope that year.

CONCLUSION

Traditionally, manufacturing is attributed to an engineering field. For nanomanufacturing, we must go beyond engineering. Once we approach the atomic-scale precision and control, fundamental physics and chemistry have to be applied. The nanoscale manufacturing is multidisciplinary involving but not limited to mechanics, electrical engineering, physics, chemistry, biology, and biomedical engineering. The future view of nanomanufacturing is the integration of engineering, science and biology. This complex task requires not only innovative research and development themes, but also a new education system for training future scientists and engineers. The goal should be on how to use nanotechnology to make microtechnology more efficient, multifunctional, and intelligent as well as faster, smaller, and achieving the impossible. Nanotechnology comes to life if we can achieve the integration of nanoscale building blocks with lithographically produced structures through self-assembly and genetically engineered growth.

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