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CARBON NANOTUBE: APPROACH FOR TARGET DRUG DELIVERY

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ABSTRACT:
A foremost and inimitable invention in the part of nanotechnology is carbon nanotubes (CNT). Crystal structures are nearly analogous to the nuclear atomic arrangement of graphite and diamond.

Carbon nanotubes have generated huge activity in most areas of science and engineering due to their remarkable physical and chemical properties. The present Review cover the Fundamental aspects, Variety of Carbon Nanotube and Drug Delivery Process by Carbon Nanotube.

Key Word: Nano technology, Nano Tube, Nano bud.

INTRODUCTION

Since their discovery in 1991 by Sumio lijima.Carbon nanotubes have generated huge activity in most areas of science and engineering due to their remarkable physical and chemical properties. No previous materials have displayed the combination of superlative mechanical, thermal and electronic properties attributed to them. These properties make nanotubes ideal, not only for a wide range of applications. Nanomedicine is the branch of medicine that utilizes the science of nanotechnology in the preclusion and cure of various diseases using the nanoscale materials, such as biocompatible nanoparticles and nanorobots. For various applications including, diagnosis delivery sensory or actuation purposes in a living organism. Drugs with very low solubility possess various biopharmaceutical delivery issues including limited bio accessibility after intake through mouth, less diffusion capacity into the outer membrane, require more quantity for intravenous intake and unwanted after-effects preceding traditional formulated vaccination process. However, all these limitations could be overcome by the application of nanotechnology approaches in the drug delivery mechanism. Drug designing at the

nanoscale has been studied extensively and is by far, the most advanced technology in the area of nanoparticle applications because of its potential advantages such as the possibility to modify Properties like solubility, drug release profiles, diffusivity, bioavailability and immunogenicity. This, can consequently lead to the improvement and development of convenient administration routes, lower toxicity, fewer side effects, improved bio distribution and extended drug life cycle is shown to bridge the barrier of biological and physical sciences by applying nanostructures and nanophases at various fields of science; specially in nanomedicine and nano based drug delivery systems, where such particles are of major interest. Nanomaterials can be well-defined as a material with sizes ranged between 1 and 100 nm, which influences the frontiers of nanomedicine starting from biosensors, microfluidics, drug delivery, and microarray tests to tissue engineering. Nanotechnology employs curative agents at the nanoscale level to develop nanomedicines. The field of biomedicine comprising nanobiotechnology, drug delivery, biosensors, and tissue engineering has been powered by nanoparticles. As nanoparticles comprise materials designed at the atomic or molecular level, they are usually small sized nanospheres. Hence, they can move more freely in the human body as compared to bigger materials. Nanoscale sized particles exhibit unique structural, chemical, mechanical, magnetic, electrical, and

biological properties. Nanomedicines have become well appreciated in recent times due to the fact that nanostructures could be utilized as delivery agents by encapsulating drugs or attaching therapeutic drugs and deliver them to target tissues more precisely with release. Nanomedicine, is an emerging field implementing the use of knowledge and techniques of nanoscience in medical biology and disease prevention and remediation. It implicates the utilization of nano dimensional materials including nanorobots,nanosensors for diagnosis, delivery, and sensory purposes, and actuate materials in live cells .

For example, a nanoparticle-based method has been developed which combined both the treatment and imaging modalities of cancer diagnosis. The very first generation of nanoparticle-based therapy included lipid systems like liposomes and micelles, which are now FDA-approved. liposomes and micelles can contain inorganic nanoparticles like gold or magnetic nanoparticles. Nanostructures stay in the blood circulatory system for a prolonged period and enable the release of amalgamated drugs as per the specified dose. Thus, they cause fewer plasma fluctuations with reduced adverse effects. Being Nano sized, these structures penetrate in the tissue system, facilitate easy uptake of the drug by cells, permit an efficient drug delivery, and ensure action at the

targeted location. The uptake of nanostructures by cells is much higher than that of large particles with size ranging between 1 and 10 μm. There are two ways through which nanostructures deliver drugs: passive and self-delivery. In the former, drugs are incorporated in the inner cavity of the structure mainly via the hydrophobic effect. When the nano structure materials are targeted to a particular site, the intended amount of the drug is released because of the low content of the drugs which is encapsulated in a hydrophobic environment. Conversely, in the latter, the drugs intended for release are directly conjugated to the carrier nanostructure material for easy delivery. In this approach, the timing of release is crucial as the drug will not reach the target site and it dissociates from the carrier very quickly, and conversely, its bioactivity and efficacy will be decreased if it is released from its nanocarrier system at the right time .

Drug designing and drug delivery process and mechanism

With the progression of Nano medicine and, due to the advancement of drug discovery/design and drug delivery systems, numerous therapeutic procedures have been proposed and traditional clinical diagnostic methods have been studied, to increase the drug specificity and diagnostic accuracy. For instance, new routes of drug administration are being explored, and there is focus on ensuring their targeted action in specific regions, thus reducing their toxicity and increasing their bioavailability in the organism. In this context, drug designing has been a promising feature that characterizes the discovery of novel lead drugs based on the knowledge of a biological target. The advancements in computer sciences, and the progression of experimental procedures for the categorization and purification of proteins, peptides, and biological targets are essential for the growth and development of this sector. In addition, several studies and reviews have been found in this area; they focus on the rational design of different molecules and show the importance of studying different mechanisms of drug release. Moreover, natural products can provide feasible and interesting solutions to address the drug design challenges, and can serve as an inspiration for drug discovery with desired physicochemical properties. Also, the drug delivery systems have been gaining importance in the last few years. Such systems can be easily developed and are capable of promoting the modified release of the active ingredients in the body. For example, Chen et al. described an interesting review Using nano carriers for imaging and sensory applications and discussed the, therapy effect of these systems. In addition, Pelaz et al. provided an up-to-date overview of several applications of nano carriers to nano medicine and discussed new opportunities and challenges for this sector. Interestingly, each of these drug delivery systems has its own chemical, physical and morphological characteristics, and may have affinity for different drugs polarities through chemical interactions (e.g., covalent bonds and hydrogen bonds) or physical interactions (e.g., electrostatic and van der Waals interactions). As an example, Mattos et al. demonstrated that, the release profile Of neem bark extract-grafted biogenic silica nanoparticles (chemical interactions) was lower than neem bark extract-loaded biogenic silica nanoparticles. Hence, all these factors influence the interaction of nano carriers with biological systems, as well as the release kinetics of the active ingredient in the organism. In addition, Sethi et al. designed a cross linkable lipid shell (CLS) containing docetaxel and wortmannin as the prototypical drugs used for controlling the drug discharge kinetics; then, they studied, its discharge profile, which was found to be affected in both in vivo and in vitro conditions. Apart from

this, other parameters, such as the composition of the nano carriers (e.g., organic, inorganic, and hybrid materials) and the form in which drugs are associated with them (such as core–shell system or matrix system) are also fundamental for understanding their drug delivery profile. Talking together, several studies regarding release mechanisms of drugs in nano carriers have been conducted. Diffusion, solvent, chemical reaction, and stimuli-controlled release are a few mechanisms that can represent the release of drugs in nano carriers as shown in Fig. 2. Kamaly et al. provided a widespread review of controlled-release systems with a focus on studies related to controlling drug release from polymeric nano carriers. Although there are several nano carriers with different drug release profiles, strategies are currently being formulated to improve the specificity of the nanostructures to target regions of the organism, and to reduce the immunogenicity through their coating or chemical functionalization with several substances, such as polymers, natural polysaccharides, antibodies, cell-membrane, and tunable surfactants, peptides, etc. In some cases where drugs do not display binding and affinity with a specific target or do not cross certain barriers (e.g. blood–brain barrier or the blood–cerebrospinal fluid barrier) , these ligand-modified nano carriers have been used to pass through the cell membrane and allow a programmed drug delivery in a particular environment. For example, hyaluronic acid (a polysaccharide found in the extracellular matrix) has been used as a ligand-appended in several nano carriers, showing promising results to boost antitumor action against the melanoma stem-like cells, breast cancer cells, pulmonary adenocarcinoma cells, as well as to facilitate intra vitreal drug delivery for retinal gene therapy and to reduce the immunogenicity of the formed protein corona.

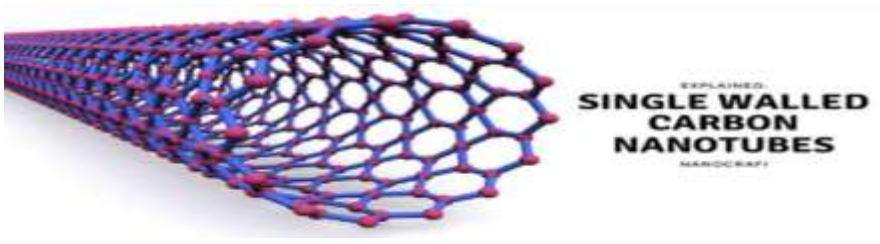
Classification of Carbon Nanotubes

1. Single-walled
2. Double-walled
3. Multi-walled
4. Torus
5. Fullerene
6. Nanobud
7. Functionalized CNTs

There are several types of CNTs. They are as follows:

Single-walled carbon nanotube (SWNT)

Single-walled nanotubes (SWNT) have a diameter of close to 1-10 nanometres, with a tube length that can be many thousands of times larger (Figure 3). The structure of a SWNT can be conceptualised by wrapping a one atom-thick layer of graphite called graphene into a seamless cylinder.



Double-wall Nanotubes (DWNT)

These materials combine similar morphology and other properties of SWNT, while significantly improving their resistance to chemicals. Double-wall nanotubes are ideal systems for studying the interwall interactions

influencing the properties of nanotubes with two or more walls. This property is especially important when functionality is required to add new properties to the nanotube. Since DWNT are a synthetic blend of both SWNT and MWNT, they exhibit the electrical and thermal stability of the latter and the flexibility of the former (Alexander et al., 2009) (Figure 4).

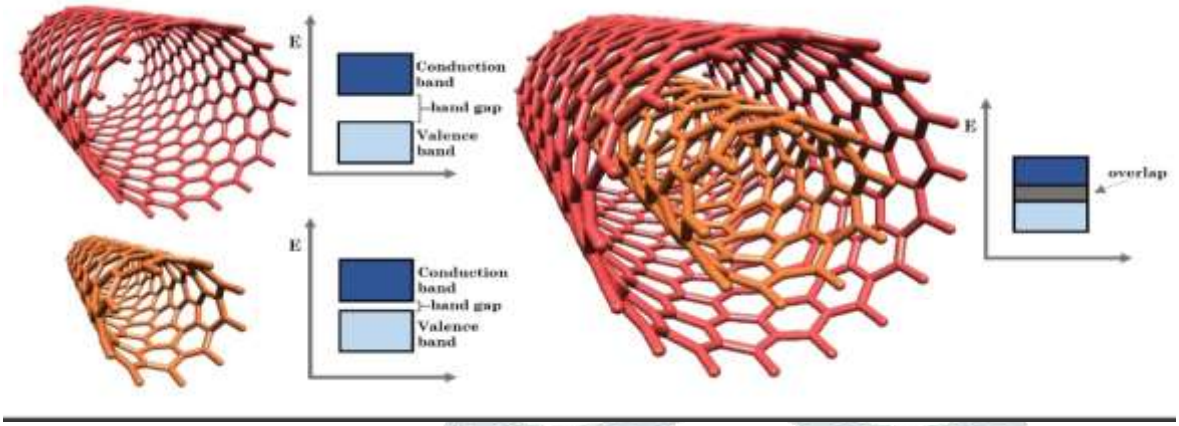


Fig. 4.Doublewall Nanotubes.

Multi-walled carbon nanotube (MWNT)

Multi-walled nanotubes (MWNT) consist of of graphite rolled in on themselves to form a tube shape (Figure 5). There are two models which can be used to describe the structures of multi-walled nanotubes. In the Russian Doll model, sheets of graphite are arranged in concentric cylinders, eg: a single-wall ednanotube (SWNT) within a larger single-walled nanotube. In the Parchment model, a single sheet of graphite is rolled in around itself, resembling a scroll of parchment or a rolled-up newspaper. The MWNT's are much stiffer thantheSWNT's, especiallyincompression.

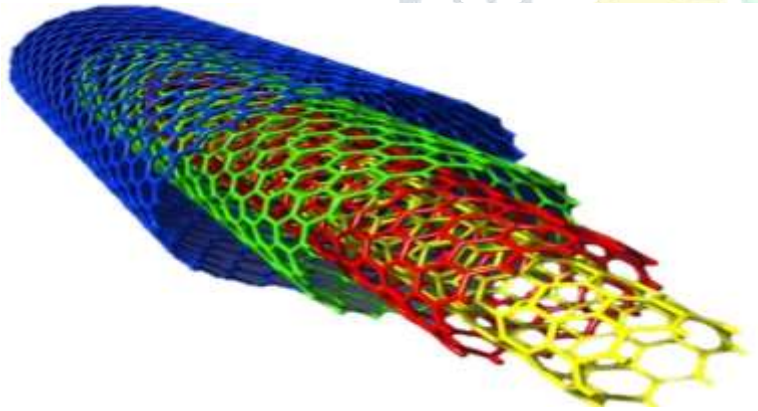


Fig. Representation of a Multiple Walled Carbon Nanotube (MWNT).

Nanotorus

A nano torus is a theoretically described carbon nanotube bent into a torus (donut shape). Nano tori have many unique properties, such as large magnetic moments, thermal stability, etc which vary widely depending on the radius of the torus and radius of the tube.

Nanobud

Carbon nanobuds are a newly discovered material combining two previously discovered allotropes of carbon: carbon nanotubes and fullerenes. In this new material, fullerene like 'buds' are covalently bonded to the outer

sidewalls of the underlying carbon nanotube (Figure 6).

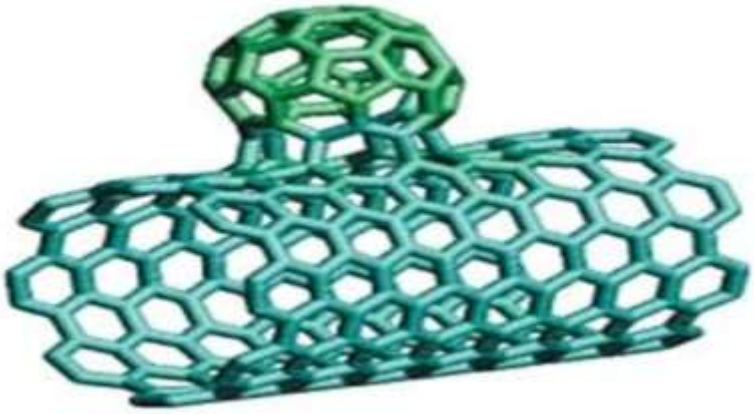


Fig. Representation of a Nanobud.

Fullerene

A fullerene is molecule composed entirely of carbon, in the form of a hollow sphere, ellipsoid, or tube. Spherical fullerenes are also called buckyballs, and cylindrical ones are called carbon nanotubes or buckytubes. Fullerenes are similar in structure to graphite. The first fullerene to be discovered, and the family's namesake Buckminster fullerene C60, made in1985 by Robert Curl, Harold Kroto and Richard Smalley.The name was homage to Richard Buckminster Fuller, whose geodesic domes it resembles. Fullerenes have since been found to occur in nature. Functionalized carbon nanotubes Functionalized carbon nanotubes are which contain additional functional groups on their surface. Carbon nanotubes when treated with mixtures of concentrated sulphuric and nitric acids, they result in the formation of carboxyl and hydroxyl groups on their surface. These activated CNTs are able to react with other functional groups favouring coupling to different compounds (Ruiz-Hitzky et al., 2008).

Single walled carbon nanotubes (SWCNTs) are functionalized using molten urea as the solvent and dispersed with arene diazonium salts in less than 15minutes (Condell et al., 2007)

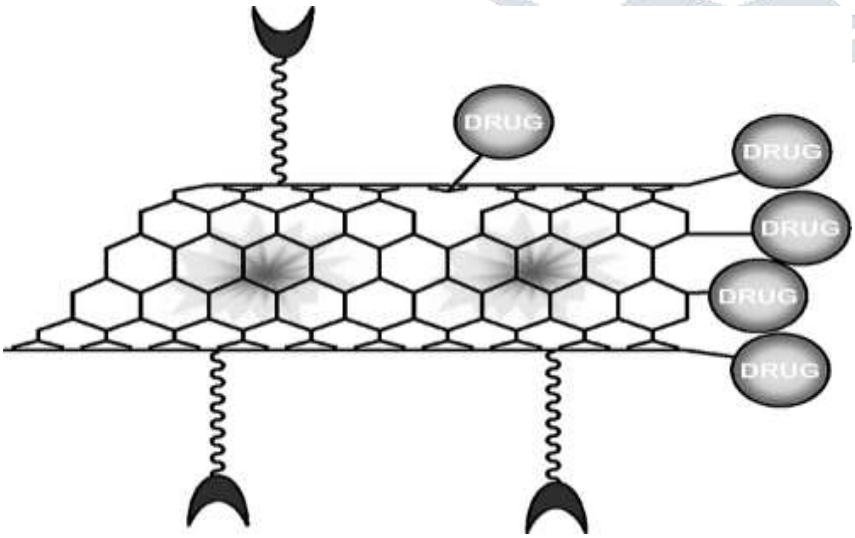


Fig. 7. Functionalised carbon nanotubes.

Conclusion:

Moreover, Carbon Nanotube has Recently Vast Use in the Field of Pharmaceutical Science. It needs to more research in Pharmacokinetic and Toxicological Field which support in future for Various Pharmaceutical and Medical application.

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