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Review Article

DRUG DELIVERY BY NANODIAMONDS

Prajapati Parimal M[1]*, Patel Krunal R[1], Ganatra Maulik H[1], Solanki Anil S[1], Sen Dhrubo Jyoti[2]
[1]I K Patel College of Pharmaceutical Education & Research, Himmatnagar, Sabarkantha, Gujarat, India
[2]Shri Sarvajanik Pharmacy College, Gujarat Technological University, Mehsana, Gujarat, India

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*Parimal Prajapati, Email: swami.parimal@gmail.com

ABSTRACT
Nanomaterials less than 100-thousand-millionths of a meter in size have the potential to radically change current drug delivery techniques with early trials showing the ability of nanomaterials to moderate the release of highly toxic chemotherapy drugs and other therapeutics with both reduced side effects and improved targeting. A nanodiamonds application in biology and nanoscale medicine highlights how nanodiamonds have emerged in clinical and medical relevance through assisting in the processes of drug delivery, cellular interrogation and detection. These nanomaterials can shuttle chemotherapy drugs to cells without producing the negative effects of today's delivery agents. Clusters of the nanodiamonds surround the drugs to ensure that they remain separated from healthy cells until they reach the cancer cells, where they are released. More benificial part is that these nanodiamonds have been shown not to induce inflammation in cells once they have done their job. Nanodiamonds are the diamond crystals less than 100 thousands million of meter in size. Delivery of drug using this system reduces the side-effects and improves the targets.
KEYWORDS: Nanodiamond, TNT, Graphite shell, Biocompatibility, Myriad

INTRODUCTION

Nanodiamond is an allotrope of carbon. Nanodiamonds are carbon-based materials approximately 2 to 8 nanometers in diameter. Each nanodiamond's surface possesses functional groups that allow a wide spectrum of compounds to be attached to it, including chemotherapy agents. The crystal structure of Nanodiamond consists of two close packed interpenetrating face centered cubic lattices; one lattice is shifted with respect to the other along the elemental cube space diagonal by one-quarter of its length. Nanodiamond has been considered for use in several medical applications due to its unique mechanical, chemical, optical, and biological properties. It has also sensing, imaging, and drug delivery properties. With the rapid development of nanoscience and nanotechnology, a wide variety of nanomaterials have been synthesized and discovered. Due to excellent properties and great potential application, a number of carbon nanoparticles have been receiving much attention. The study associated with the interface between Nanodiamond and life sciences which is important for development of effective drug delivery systems[1-2]. Figure-1

Nanodiamond Structure

The nanodiamonds also referred to as ultradisperse diamonds are particles in the 2–8 nm size range. The energies of graphite, diamond, and fullerene on the basis of density functional theory to conclude that diamond could be the stable phase of carbon clusters. Nanodiamond is often described as a crystalline diamond core with a perfect diamond lattice surrounded by an amorphous shell with a combination of sp2/sp3 bonds or onion-like graphite shell.[3] Figure-2

Synthesis of nanodiamonds

A mixture of trinitrotoluene (TNT) and hexogen are detonated, nanodiamonds with diameters of about five nanometers are formed. The quicker the cooling after the detonation, the greater the yield of nanodiamonds, which can reach up to 90%. To obtain the nanodiamonds from the soot, high pressure and high temperature boiling in acid is done, which also gets rid of metal from the detonation chamber that contaminates the nanodiamond yield. The nanodiamonds have a diamond cubic lattice, thus having the name "nanodiamond."[4] Figure-3

Properties of nanodiamonds

- They have a larger surface area, so larger amounts of drugs can be placed on the particles.
- They are very soluble in water, thus allowing them to travel throughout the body easily.
- They are smaller, and can be used to target specific areas in the body.
- They can be easily produced and in large amounts. [5]

Nanodiamond-insulin administration

One medical use for the nanoparticles is to administer insulin, which acts as a growth hormone, into the body to

help fight infection after wounded. The nanodiamonds with insulin can then be put in gels, ointments, and bandages. Since nanodiamonds tend to cluster naturally after extraction, thus having a relatively large surface area, large amounts of insulin can be placed on the nanodiamonds. When nanodiamond-insulin clusters are in an environment with a slightly basic pH, the insulin releases itself from the nanodiamonds. Because a bacterially infected wound has a pH higher than the physiological pH of 7.4, the insulin will only release where the infected area is. Since localized release of therapeutic medicine is becoming more and more important. [6]Figure-4

Benefits

- Drugs can be slowly released over time.
- Nanodiamonds can trap nearly 5 times compared to conventional drug delivery.
- The new system localizes the drugs to minimize and mitigate side effects
- It can be combined with a wide variety of drugs and RNA

How Nanodiamonds Work?

Nanodiamonds drug delivery system shows a new path to the medical science. This technology reveals many roads toward the effective and safe treatment of Cancer. Nanodiamonds have many other advantages that can be utilized in drug delivery. They can be functionalized with nearly any type of therapeutic. They can be suspended easily in water, which is important for biomedical applications. The nanodiamonds, each being four to six nanometers in diameter, are minimally invasive to cells, biocompatible and do not cause inflammation, a serious complication. New technology may make cancer drugs more effective and ease the burden of chemotherapy. Combination of cancer medicine with tiny particles of carbon called nanodiamonds. These diamonds are nothing like the gems used in jewelry. They're just a few nanometers across. A nanometer is one billionth of a meter. Nanodiamonds are small carbon particles that kind of resemble like an angular soccer ball. Cancer is usually treated with a number of chemotherapeutic agents but the results and outcomes are not 100%. But now a new shine have reached us giving a promise to our next generation about 100% and perfect cure of cancer. This new technology is the use of Nanodiamonds having a coat of the drug and proteins that targets the Caner cell in body and destroy the cancerous cells without affecting any normal cell. Nanodiamonds are the diamond crystals less than 100 thousands million of meter in size. Delivery of drug using this system reduces the side-effects and improves the targets. The nanodiamond surfaces is that they like to attract water, for example, as well as other molecules, like drugs. This property to bind anti-cancer drugs to nanodiamonds, the value of nanoparticles made of diamond is multifaceted. Made of carbon, they're nontoxic, and the body's immune system doesn't attack them. They can bind tightly to a variety of molecules and deliver them right into a tumor. And because they are only 2 to 8 nanometers in diameter, they are easy for the kidneys to clear from the body before they block up blood vessels, a long-standing problem in nanoparticle therapy.These nanomaterials can shuttle chemotherapy drugs to cells without producing the negative effects of today's delivery agents. Clusters of the nanodiamonds surround the drugs to ensure that they remain separated from healthy cells until they reach the cancer cells, where they are released. More benificial part is that these nanodiamonds have been shown not to induce inflammation in cells once they have done their job. [7]Figure-5

Nanodiamonds for nanomedicine

Carbon nanomaterials for biological applications revealed that carbon nanodiamonds are much more biocompatible than most other carbon nanomaterials, including carbon blacks, fullerenes and carbon nanotubes. The noncytotoxic nature of nanodiamonds, together with their unique strong and stable photoluminescence, tiny size, large specific surface area and ease with which they can be functionalized with biomolecules, makes nanodiamonds attractive for various biomedical applications both in vitro and in vivo.The synthesis and surface functionalization of diamond nanoparticles for nanomedicine as well as an overview of the recent progress in this exciting field by focusing on the potential use of nanodiamonds and their derivatives for single particle imaging in cells, drug delivery, protein separation and biosensing. [10] Figure-6

Safe gene therapy with Nanodiamonds

Gene therapy holds promise in the treatment of a myriad of diseases, including cancer, heart disease and diabetes, among many others. However, developing a scalable system for delivering genes to cells both efficiently and safely has been challenging. The power of nanodiamonds as a novel gene delivery technology that combines key properties in one approach: enhanced delivery efficiency along with outstanding biocompatibility. Nanodiamonds also are extremely effective at delivering therapeutic proteins. The application of nanodiamonds for chemotherapeutic delivery and subsequently discovered that the nanodiamonds also are extremely effective at delivering therapeutic proteins. [11] Figure-7

APPLICATIONS

- Nanodiamonds has a ability to deliver drugs into a single cell and

- It delivers a precise dose to one cell and observe its response relative to its neighbors.
- It also investigates the ultimate effectiveness of novel treatment strategies via a spectrum of internalization mechanisms."
- Nanodiamonds possess numerous hallmarks of an ideal drug delivery system and are promising platforms for advancing cancer therapy
- They're nontoxic, and the body's immune system doesn't attack them. They can bind tightly to a variety of molecules and deliver them right into a tumor.
- Using nanodiamonds, tiny particles of carbon, as a drug delivery system, to treating breast and liver cancer tumors that are resistant to chemotherapy.
- The drug-nanodiamond complexes had no negative effect on the white blood cell count. This is especially important for cancer treatment: if the white blood cell count drops below a certain level, treatment is stopped due to the risk of major complications. [12]

CONCLUSION

Nanodiamonds having a coat of the drug and proteins that targets the Caner cell in body and destroy the cancerous cells without affecting any normal cell and they can bind tightly to a variety of molecules and deliver them right into a tumor.

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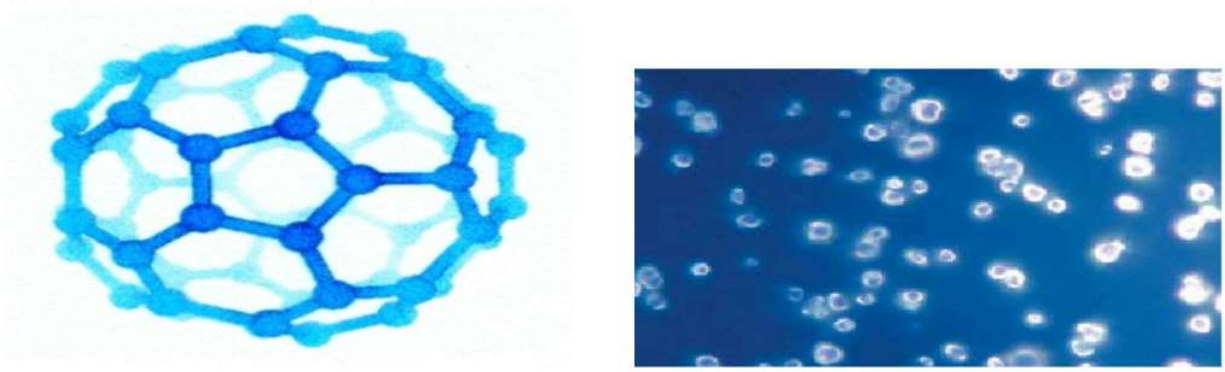


Figure-1: Nanodiamond

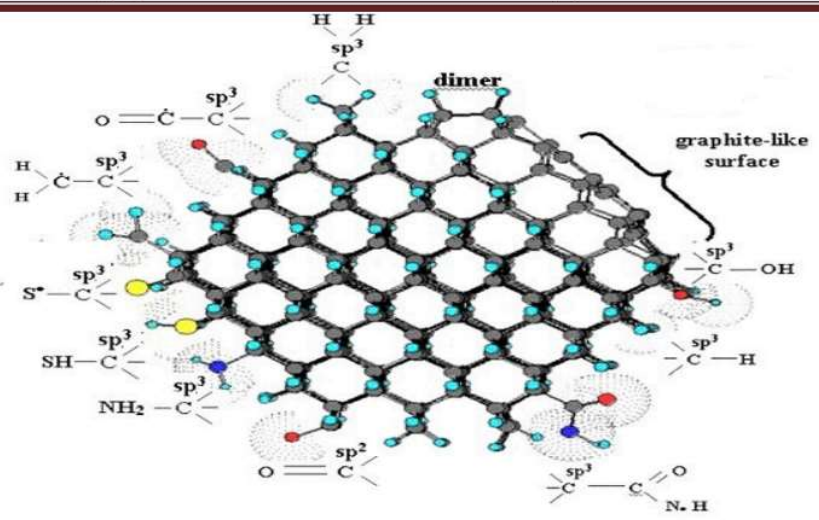


Figure-2: Nanodiamond Stracture

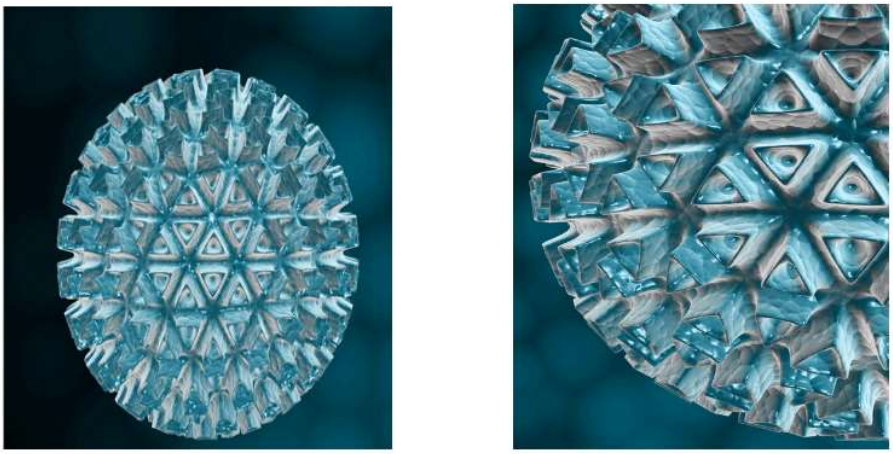


Figure-3: Synthesis of Nanodiamond



Figure-4: Nanodiamond and Insulin Administration

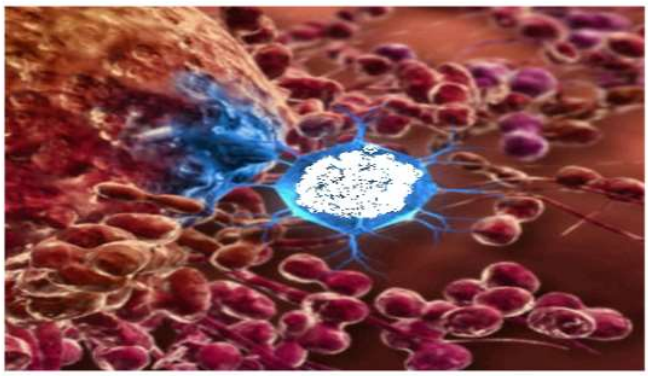


Figure-5: Nanodiamond in cancer treatment



Figure-6: Nanomedicine

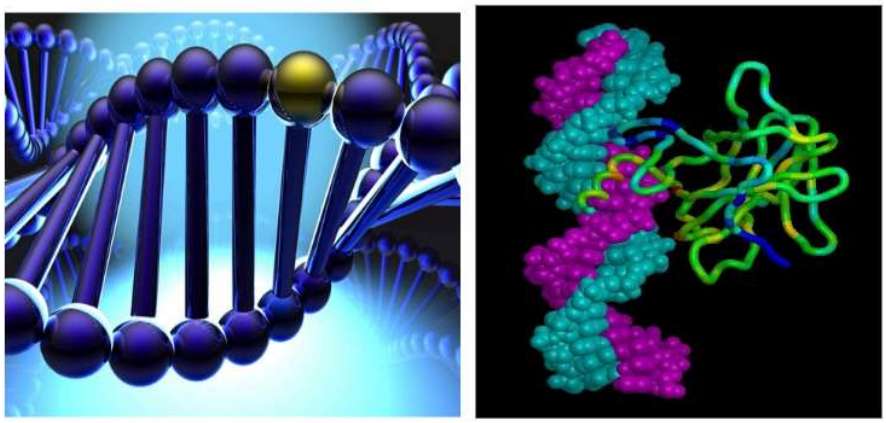


Figure-7: Gene therapy with Nanodiamonds