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NOVEL INNOVATION OF NANODIAMOND IN MEDICINE FIELD

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ABSTRACT

Utilize diamonds in medicine is a novel novelty in the medical field. The exclusive nanodiamond properties have established excellent presentations in assorted fields mainly in pharmaceutical as a drug delivery system and biotechnology. To its superior biocompatibility Nanodiamonds provide as flexible Platforms that could be used enclosed inside microfilm systems based on polymers. Nanodiamonds are complex with a medication that allows the drug to be released sustainably / slowly for at least one month, with a substantial amount of drug in reserve. Nanodiamonds are relatively inexpensive, allowing the broad effect of these devices on a variety of physiological disorders, e.g. Use as a local chemotherapy patch, or as a pericardial tool to restrain inflammation after open-heart surgery. Nanodiamond patch could be used to take care of a localized region where residual cancer cells might stay after a tumor is removed. Nano-diamonds can be used to explore a broad range of therapeutic classes, including additional tiny molecules, therapeutic antibodies, proteins, RNAi. Nanodiamond relevance in biotechnological and medical fields is currently in constant progress. Biocompatibility, condensed dimensions, and high surface chemical interaction are the specific description that makes nanodiamonds ideal intracellular carriers of bioactive compounds. With confocal microscopy, it was established that nanodiamonds were capable to enter in cell cytoplasm but they remained entrenched in nuclear membrane just exposing a few little portions into the nuclear area.

Keywords*:* - Nanodiamond, diamond lattice, Structure, synthesis, insulin administration

INTRODUCTION

Nanodiamonds (NDs) are carbon-based nonmaterials that offer a large surface area. They can be functionalized with diverse ligand molecules, which can be used to conjugate a variety of compounds or drugs. Equivalent as bulk diamond, this inimitable characteristic feature of ND particles promises a superior degree of template flexibility predominantly around the bent surface where electrons are unstable. NDs can be easily doped with nitrogen and possess nitrogen-vacant (NV) defects in their crystal lattice which compose them appropriate as photoluminescent probes for centers numerous in vivo and in vitro relevance. The existence of the NV centers - a nitrogen atom subsequently to a vacancy in NDs, leads to useful fluorescence properties. They release bright fluorescence at 550-800nm from NV centers formed by high-energy ion beam irradiation and consequent thermal annealing. The excellent emission property, together with slight cytotoxicity and easiness of surface functionalization, makes NDs a capable fluorescent probe for single-particle tracking in diverse environments in addition to using them as biomarkers and in bio labeling studies.

Nanodiamond Structure:

ND is an allotrope of carbon. NDs are carbon-based materials roughly 2 to 8 nanometres in diameter. Each ND's surface possesses functional groups that permit an extensive spectrum of compounds to be attached to it, as well as chemotherapy agents. The crystal structure of ND consists of two secure packed interpenetrating faces cantered cubic lattices; one lattice is shifted as regards the other along with the elemental cube space diagonal by one-quarter of its length (Figure 1).

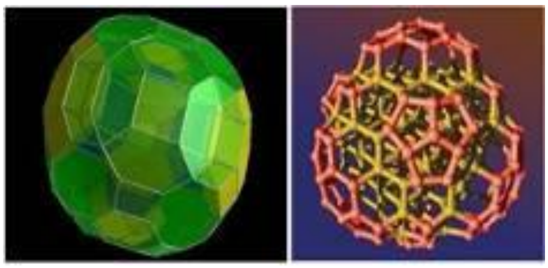

Figure No. 1: Crystalline structure of ND

The NDs as well-referred to as ultra disperse diamonds are particles in the 2-8 nm size range. ND is often described as a crystalline diamond core with a perfect diamond lattice encircled by an amorphous shell with a blend of sp2/sp3 bonds or an onion-like graphite shell. NDs have clustered carbon atoms with both graphitic (sp2) and diamondoid (sp3) bonds. The two types of bonds can be interchangeable, for example, the stretched face of diamond is a graphene plane. In reverse, the puckered graphene may become a diamond surface. This interchangeability allows ND particles to be flexible templates, particularly around the curved surface where electrons are unstable.

NANODIAMONDS SYNTHESIS

In the phase diagram of carbon (Figure 2) there is a region at very high pressure and temperatures where the diamond is steady. Hence, normally it is necessary to maintain according to conditions for its invention.

Different methods are used to produce NDs:

1. Detonation Nanodiamond

Detonation ND (DND), frequently also called an ultradispersed diamond (UDD), is a diamond that originates from a detonation. And can be produced by detonating a mixture of trinitrotoluene (TNT) and hexogen (RDX) (Figure 3) and then gathering the remaining soot.

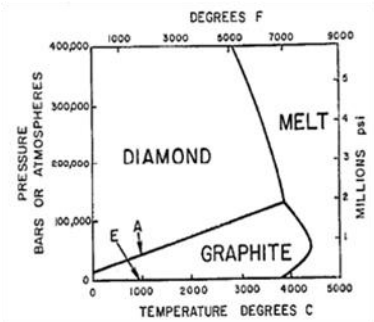

Fig 2: Phase Diagram of Carbon

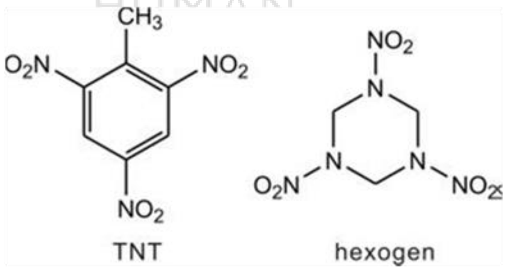

Fig 3: Structural formulae of two explosives generally employed for detonation synthesis

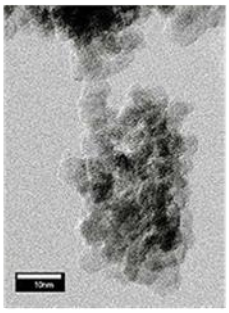

Fig 4: Detonation ND, TEM image

This design is that pure ND can be created by the explosion of a diamond blend and will then form by chemical purification. The soot leftover essentially contains tiny diamonds, which quantify four nanometers in size. However, for these diamonds to look and shine anything like diamonds they must be exposed to a high-energy electron beam and then heated 800 degrees Celsius. The diamond yield after detonation significantly depends on the synthesis situation and particularly on the heat capacity of the cooling medium in the explosion chamber (water, air, CO_2, etc.).

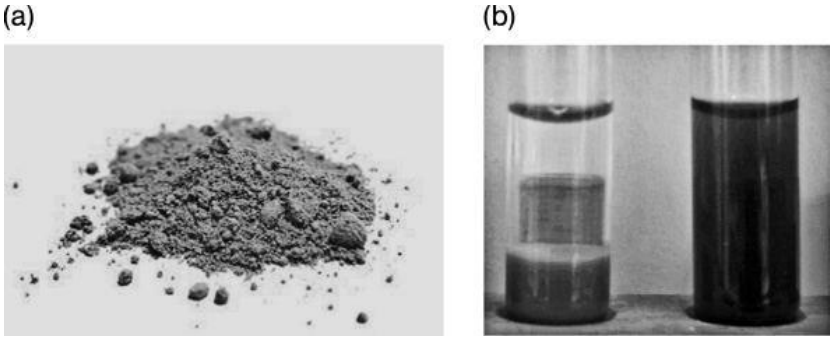

Figure No. 5: Detonation diamond as a powder (a), as an unstable suspension in water (center) and as completely deagglomerated dispersion in water (b).

2. Ultrasonic Cavitations Method

Diamond nanocrystals can in addition to synthesized from a suspension of graphite in organic liquid at atmospheric pressure and room temperature using ultrasonic cavitations. The yield is just about 10%. The cost of NDs formed by this method is estimated to be competitive with the HPHT method.

3. Pulsed-laser irradiation:

A substitute synthesis method is the irradiation of graphite by high-energy laser pulses. The arrangement and particle size of the obtained diamond are quite parallel to that obtained in the explosion. In particular, numerous particles reveal multiple twinning.

Properties of Nanodiamonds

1. It is achievable to use nanodiamonds for the creation of nano-composite materials, selective catalysts and adsorbents, elements of nano-electronics, and materials utilized in biology and medicine.

2. Nanodiamonds are capable of enhancing the superiority of magnetic recording systems, gum and Indian rubber, abrasive tools, lubricants, polymeric compositions, and micro-abrasive and polishing compounds.

3. Nanodiamonds exhibit superior optical and mechanical properties. They have tunable high surface areas and surface structures.

4. They are ultimate for biomedical applications thanks to their non-toxicity. They have found use in applications such as tribology, bioimaging, drug delivery, and tissue engineering.

5. They can supply as a filler material for nanocomposites and as protein mimics.

BENEFITS

1. The drug can be gradually released over time.

2. Nanodiamond can entrap nearly 5 times compared to conventional drug delivery.

3. The novel system localizes the drugs to minimize and mitigate side effects.

4. It combined with an extensive variety of drugs and RNA.

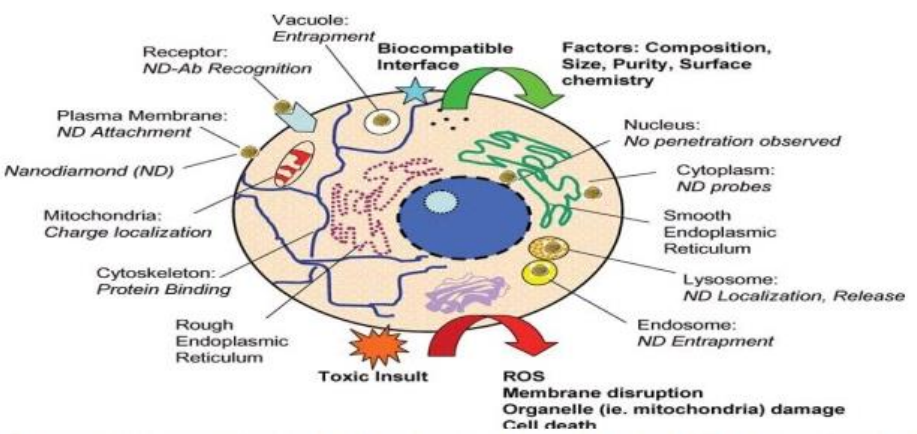

Figure No. 6: Interactions nanodiamond (Nanodiamond) particles including biomolecular binding

APPLICATION:

Application of NDs in Drug Delivery System: Carbons nanoparticles acquire penetrate through the cells easily, small size and can be surface functionalized. These properties enabled their purpose in designing drug delivery vehicles for attaching minute peptides and molecule drugs.

Applications of NDs Based Hydrogel: This material as well provides superior contact of the drug complex to enlarge access to the interior of the cells. ND based hydrogels were conjugated with the anticancer cell proliferation-inhibiting and apoptosis-stimulating paclitaxel-DNA via fluorescently categorized oligonucleotide strands, and with anti-EGFR monoclonal antibodies. The chance of these conjugates was considered on human breast cancer cell lines (MDA-MB-231 and MCF7).

NDs in Stem Cells: NDs can be utilized for tracking stem cells in vivo devoid of distressing their normal biology. The NDs have also been used for target-based delivery of drugs in the stem cells. For instance, epirubicin, an anthracycline anticancer drug attached to NDs was delivered in hepatic cancer stem cells to overcome chemoresistance.

Nanodiamonds for brain tumors: Researchers have developed a novel drug-delivery system in which minute particles called nanodiamonds are used to carry chemotherapy drugs directly into brain tumors. The innovative method was found to result in higher cancer-killing efficiency and slighter amount harmful side effects than offered.

Nanodiamond Embedded Microfilm Devices for Localized Chemotherapeutic Elution:

In this approach, nanodiamonds (2-8 nm diameter) were physically bound with a chemotherapeutic agent such as doxorubicin hydrochloride (DOX) that were embedded within a perylene C polymer microfilm through a facile and scalable process.

Nanodiamond in biomedical applications: Due to its chemical inertness, thermal conductivity, low cytotoxicity, and hardness nanodiamond could be applied as coating materials of implants, other surgery tools, etc. in biomedical fields.

Drug delivery vehicles: The uptake of nanodiamond by alive cell originate in the biological nanodiamond research facilitated the use of nanodiamonds as drug carriers and delivery vehicles. Nanodiamonds acquire numerous hallmarks of an ideal drug delivery system and are promising platforms for advancing cancer therapy. They're non-toxic, and the body's immune system doesn't attack them. They can connect strongly to a variety of molecules and deliver them right into a tumor.

Nanodiamond-insulin administration: One medical use for the nanoparticles is to manage 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 bandages, gels, and ointments.

Diamond-based medical devices: Diamond coatings have been applied to several medical devices in recent years, including heart valves, temporomandibular joint prostheses, and microelectromechanical systems, to extend implant lifetime.

Mental health marvels: Using Diamond's bright beams, scientists have determined the exact structure of a molecule in the brain that is concerned with stress and can cause depression and anxiety. The finding could be an early step in developing new drug treatments for these conditions.

Combating dementia: Alzheimer's is a devastating state that we know very little about. Researchers are using Diamond to detect and evidence biological processes that alter in Alzheimer's. Their work may supply treatments that protect against the progression of the disease.

Advancing antibiotics: Diamond is helping to battle the rise of antibiotic-resistant bugs by allowing scientists to uncover the mechanisms by which bacteria defend themselves against drugs. A group of scientists has used Diamond to determine how certain bacteria construct their outer layer of defense, as long as a target for new classes of antibiotics that would avoid current resistance mechanisms.

Virus evolution: There are extra viruses on Earth than all animal life and bacteria, plant combined and they can evolve much faster than any living thing. Research at Diamond is serving us to appreciate more about the way viruses evolve; this knowledge prepares us to tackle viruses that pose a serious threat now and in the future.

Nanodiamonds Coupled With Plant Bioactive Metabolites: In a recent study, nanodiamonds were conjugated with plant minor metabolites, quercetin and ciproten. Since drug-loading on nanoparticles was sturdily conditioned by their chemical surface, different types of nanodiamonds (oxidized, wet chemical reduced and plasma reduced) were synthesized in this work and then functionalized with plant compounds.

Fast Optical Process: There are plenty of applications outside of the medical realm as well. Currently, optical transistors (flow regulators that operate the same way on light beams that electronic transistors operate on electrons) are created using special dye molecules. But since these types of optical devices are only able to operate at tremendously low temperatures, any practical use outside of a lab environment was more or less out of the questioning. The nanodiamond ones work at room temperature. A virtual game changer and the thing that could make optical processing work in any practical sense. And all this could be little more than a decade away.

CONCLUSION

Nanodiamond drug system shows novel innovation in medical science. They have various advantages. They can be functionalized with nearly any type of therapeutic. Current developments involving the use of diamonds in sensing, imaging, prostheses, and drug delivery applications are reviewed. These developments propose that diamond-containing structures will offer considerable improvements in the diagnosis and treatment of medical conditions over the coming years they can be effortlessly balanced in water which is important in biomedical application, as it's diameter is in nanometer it is biocompatible and does not cause inflammation, a serious complication. Tiny carbon particles can be combined with cancer drugs and used to form nanodiamond which is nothing similar to gems used in jewelry which is used in cancer therapy. In general in cancer therapy number of chemotherapeutic agents are used but the consequence and outcomes are not 100%, but now nanodiamonds having a coat of the drug and protein that targets the cancer cell and destroys them without affecting biocompatible than other carbon nanomaterials. The nanotoxicity nature of nanodiamond with the exclusive strong and stable photoluminescence, tiny size, large surface area with which they functionalized with a biomolecule, makes it attractive for various biomedical applications both in vitro as well as in vivo. Also, their use in single-particle imaging in a cell in drug delivery reduces side effect and progress the target.

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