

Nanodiamonds as a template for drug delivery and targeting

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Nanodiamonds are carbon nanoparticles that have a shortened octahedral structure with about 2-8 nm in diameter and can deliver a wide variety of therapeutics including small molecules, proteins and nucleic acids. The unique features of diamond nanoparticles include their surface properties, non-toxic nature, optical, chemical and biological properties, innate biocompatibility, facile processing parameters and scalability. They have gained immense attraction for several applications including drug and gene delivery, imaging, diagnostic and therapeutic platforms. As nanomaterials have a unique property of specific targeting, they are highly used for treatments like cancer for site-selective drug applications. A combination of material science and drug delivery technologies has led to the development of nanotechnology as a new alternative for efficient transportation and translocation of therapeutic molecules. Drug delivery mainly focuses on optimising drug therapy by simplifying drug administration and improving effectiveness and clinical safety. Specific target drug delivery has reduced side effects, improved patient compliance and decreased dosing frequency. For the development of a successful targeted drug delivery system, nanodiamonds should release drugs slowly into the blood circulation, should retain their drug content until the target site is reached, and deliver the drug at the required rate and amount to effectively treat the pathological condition.

The highly explored application of nanodiamonds is as a novel drug carrier to enhance efficacy and reduce the toxicity of therapeutic agents. One of the attractive advantages of nanodiamonds is that they are versatile since one nanocrystal can carry several drug molecules. Nanopores which are 8-10 nm in diameter are formed within the network of aggregates formed by the nanodiamond-drug complex, and drug molecules are trapped within the pores to strengthen nanodiamond-drug interaction. With the rapid growth of the use of nanodiamonds, there is also an increase in the potential risks and concerns regarding the exposure of nanodiamonds to humans and the environment. Toxicity studies of nanodiamonds have revealed that in some cases, the addition of serum to cell culture media has significant effects on particle toxicity, possibly due to changes in agglomeration or surface chemistry. The particular location and deposition of nanodiamonds within the body has to be controlled for protection and retaining the potency of the conjugated therapeutic agent. Hence, clinical approaches using nanodiamonds require further investigation of nanodiamonds and their conjugates. However, small-molecule therapeutic agents have been successfully coated on nanodiamond platforms and introduced into living cells and have been interpreted as safe and efficient. To summarise, nanodiamonds play an important role in drug delivery by providing improved stability, compatibility and sustained drug release into the circulation as well as targeting specific receptors for biomedical applications. Furthermore, nanodiamonds could be used to exploit the areas of therapeutic agents for the development of delivery vehicles for gene therapy, tissue scaffolds, diagnostic probes and medical devices in the near future.

Keywords: Nanodiamonds, Drug delivery, Drug targeting, Cancer, Therapeutics, Biomedical applications

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