Opinion

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Functionalized Nano Diamonds: Improving Biomedical Features Using Rare-Earth Elements

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ABSTRACT

Abbreviations: REE: Rare-Earth Elements; MR: Magnetic Resonance; LA: Lanthanum; CE: Cerium; PR: Praseodymium; ND: neodymium; PM: Promethium; SM: Samarium; EU: Europium; GD: Gadolinium; TB: Terbium; DY: Dysprosium; HO: Holmium; ER: Erbium; TM: Thulium; YB: Ytterbium; LU: Lutetium

Opinion

Nano diamonds (NDs) or diamond nanoparticles consist of single-crystal diamonds of 4-5nm that presents sp3 carbon as the main component with high physical and chemical properties. NDs exhibit tunable surface, excellent biocompatibility and large surface area for conjugation of molecules like drugs and genes for their intracellular and extracellular delivery [1]. Surface functionalization of NDs is necessary to improve the circulation half-life and avoid their faster elimination via opsonization by phagocytes in the human body which makes them unsuitable for sustained drug delivery [2]. Functionalized NDs have emerged as a good solution to improve the NDs performance for delayed drug delivery, image probes, or implant coatings in biological systems [1]. In a recent paper, a team of Zhengzhou researchers fabricated covalently functionalizing NDs with rare-earth elements (REE, Eu^{3+}, and Gd^{3+}) 2-thenoyltrifluoroacetone (TTA) complexes to obtain nanoparticles with simultaneous fluorescence/MR imaging and drug-delivery capabilities [3]. The in vitro/in vivo assays demonstrated the potential of ND-TTA: Eu3+, Gd3+ for optical and magnetic resonance (MR) imaging as also a good drug storage capability that reaches 375μg/mg towards anticancer drug doxorubicin.

In the last years, NDs have been considered as promising drug carriers to deliver a broad range of therapeutics due to their advantageous features including chemical stability, good biocompatibility, functionalization versatility, unique surface electrostatics, and the large surface specific area, etc. [4-6]. Many of chromophores have been combined noncovalently onto the ND surface, e.g., cytochrome c and fluorescein isothiocyanate. But precise imaging and long-time tracking have been harmed by the inevitable autofluorescence, photo-blinking, and photo-bleaching properties from organic compounds [3]. REE are a group of metals comprised of fourteen lanthanide elements [lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), lutetium (Lu)], yttrium (Y) and scandium (Sc) [7]. These elements presenting unique physical and chemical properties have rendered them indispensable for a growing number of high-tech technologies [8-9].

REE has been used in many health and medical applications as possess good optical properties. These elements have been applied to tomography scans, magnetic resonance images, positron emission tomography imaging and X-rays [10]. Nowadays, REE has also been considered on the anti-cancer treatment because of its therapeutic radioisotopes, especially as agents in

radioimmunotherapy and photodynamic therapy [11]. The use of REE into health and medical applications is now well established. The NDs-based multi-functional hybrid rare-earth complex can emit bright red luminescence which has long lifetime reaching 0.68 ms much longer than that of auto-fluorescence from bio-tissues. Furthermore, these ND-TTA: Eu^{3+}, Gd^{3+} composites [3] are low-toxic and may provide a promising nanoplatform for optical/MR multimodal imaging. Biomedicine requires powerful imaging techniques of the single-molecule scale to the whole organism, either for fundamental science or diagnosis as well as powerful drug carriers; and rare earth-functionalized nano diamonds showed are promising for dual-modal imaging and drug delivery biological applications. This discovery will be fundamental to the development of new technologies to be used in medicine.

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Conflict of Interest

No conflict of interest.

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