Diamonds – The doctors's best friend?!

Most people know about diamonds as jewelry and as the hardest material that can cut nearly everything. It is also known that what makes diamonds unique is the crystalline structure, which is brought about primarily with high temperature and pressures. It is possible to synthetically make diamonds utilizing controlled explosions. What is obtained is not hand held chunks but rather particles of carbon, just a few hundred atoms across, which still have the diamond crystalline structure - nanodiamonds.

Nanodiamonds, as the name implies, have diameters on average of about 5 nanometers. They can be used to strengthen materials, change optical properties, or provide wear protection. The surface of the as produced nanodiamond is surrounded by graphitic carbon which can be chemically modified to obtain or enhance a desired property or compatibility with other materials. If required, this graphitic shell can be removed by oxidation, exposing the neat diamond surface. More recently, nanodiamonds have gathered interest as a drug delivery system. To be used for this purpose, they must be bio-compatible – this means not toxic for humans and animals – and there should be little to no side effects from the presence of the particles. The second is that the drug should go to where it is needed. This means that the drug carried on the surface of nanoparticles should not leak off or de-bind before it is delivered to the target in the body. Materials that are considered for drug delivery systems must go through a multitude of tests to identify how well they meet these requirements.

While the work is still on-going, currently nanodiamonds have been found to be biocompatible in all studies that have been performed so far. The work for understanding how well they can be used for drug delivery was published in the Journal of Colloid and Interface Science by a team of scientists from Drexel University and Missouri University of Science & Technology. The study focused on fundamental aspects of drug uptake and release. The adsorption and desorption profiles of tetracycline and vancomycin, two well-known antibiotics, were studied. The surfaces of the nanodiamonds used were chemically modified to tune binding strength and maximum load of the antibiotics on the nanoparticles. The controlled drug release from diamond nanoparticles was studied by changing the acidity of the solution and quantifying the amount leaving the surface.

By modifying the surface of the nanodiamonds, it is possible to control how strongly a specific drug holds to the surface of the nanoparticles. The study demonstrated that it is possible to increase the strength of binding, however this can also limit the loading of the drug. Rate of the drug release depends on the environment, which makes it possible to trigger the drug release in response to slight differences in the acidity from normal, which typically occur in pathology sites such as wounds and tumors. As a multimodal therapeutic and diagnostic platform, these tiny diamond particles show a great promise for precisely delivering medicine to the brain and other locations in the body, and helping to limit the amount of medicine to where it is need to treat the disease.

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