OPINION

Functional nanomaterials and their function

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ABSTRACT

At least one of the dimensions in functional nanomaterials is in the nanometer range, a size range that can give them special optical, electronic, or mechanical properties that are very distinct from those of the equivalent bulk material. They have a very high area to volume ratio due to their small size and can be further surface-engineered to provide particular functional characteristics that the bulk materials lack.

Key Words: *Nanomaterials; Plasmonics; Refractive index*

INTRODUCTION

The study of nanomaterials was initially motivated by a desire to learn more about novel phenomena like plasmonics, negative refractive index, information transfer between atoms, and quantum confinement. As research matured, an era of application-driven research began, which was more likely to have a genuine social effect and generate genuine economic value. Indeed, a sizable portion of the global catalyst market is already occupied by nano-engineered materials, and various nanoparticle kinds have moved from the lab to the bedside. On-site medical tests are performed using gold nanoparticles, MRI diagnostics are improved by magnetic nanoparticles (SPIONs), and ovarian and metastatic breast cancers are treated with drug-loaded nanoparticles.

Materials in the nanoscale range are used as diagnostic tools or to deliver therapeutic agents to specific targeted sites in a controlled way in nanomedicine and nano delivery systems, which is a relatively new but quickly developing science. By delivering precise medications to specific locations and targets, nanotechnology provides numerous advantages in the treatment of chronic human diseases. There have recently been many remarkable uses of nanomedicine in the treatment of different diseases. Through a thorough examination of the discovery and application of nanomaterials in improving both the efficacy of new and old drugs and selective diagnosis through disease marker molecules, the current review provides an updated summary of recent advancements in the field of nanomedicines and nano based drug delivery systems.

Nanostructures allow the release of amalgamated drugs at the prescribed dose because they remain in the blood circulation system for a long time. They consequently result in fewer plasma changes and worse side effects. Due to their nanoscale, these structures can easily enter the tissue system, make drug delivery more effective, and guarantee that the drug acts where it is intended. Nanostructures are much more readily absorbed by cells than big particles between 1 and 10 m in size. As a result, they work together directly to heal the sick cells more effectively and with fewer, if any, side effects.

When using nanomaterials for medication delivery, the physicochemical characteristics of the drug are taken into consideration when choosing the nanoparticle. The use of bioactive natural substances in conjunction with nanoscience is highly appealing and has grown significantly in recent years. When it comes to the delivery of natural remedies for the treatment of cancer and many other illnesses, it offers a number of benefits. As a result of their numerous distinctive properties, including their ability to induce tumor-suppressing autophagy and function as antimicrobial agents, natural compounds have been thoroughly investigated in the treatment of diseases. Curcumin and caffeine have been linked to autophagy, whereas cinnamaldehyde, carvacrol, curcumin, and eugenol have been linked to antimicrobial properties. By incorporating nanoparticles, their characteristics, such as bioavailability, targeting, and controlled release, were enhanced. For instance, the bioactive ingredient in Nigella sativa called thymoquinone is examined after being enclosed in a lipid nanocarrier. Its bioavailability increased six fold after encapsulation compared to free thymoquinone, protecting the GI tract. Additionally, it improved the natural product's pharmacokinetic properties, improving therapeutic benefits.

Future optical devices could have unprecedented utility thanks to the optical nanomaterials found in nature. Numerous animals' vibrant hues are the result of physical interactions between light and multipurpose, nanostructured materials. Although these structures usually have a length scale in the 100-nm range, their morphology can vary significantly. These biological nanostructures are produced under ambient conditions using biomaterials in a controlled way. Both equilibrium self-assembly and far-from-equilibrium and growth processes are used in nature's creation processes.

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This makes the formation processes of the colors as well as the colors themselves extremely important from a technological and ecological standpoint. However, due in part to a dearth of in vivo imaging techniques, little is known about the formation processes for many biological nanostructured materials. Here, we outline the arsenal of naturally occurring multifunctional nanostructures and the state of our comprehension of their out-of-equilibrium assembly mechanisms.

The properties and uses of such new nanomaterials have also been the subject of a significant amount of study. Before the first acknowledged article on molecular manipulation appeared, more than two decades had passed. Since then, interest in nanomaterials and nanotechnology has grown, and it is now possible to use them for smart textiles, energy harvesting and conversion, computer processors, biomedicine, biosensors, and automotive, aircraft, and other industries.

This Special Issue includes some papers relating to the energy applications of nanoparticles. Different classes of nanostructured gels exist, as well as the most current developments in the area. Thewriters concentrated in particular on the potential future developments in thisdifficult field. With uses spanning from extraction and purification to catalysis, nanostructured gels are becoming more and more popular as attractive, useful materials in the field of energy. By adjusting various elements, such as gelator types and concentrations, pH, temperature, gelling techniques, etc., the characteristics of the Nano gel can be tailored. Nanostructured gels could also be used to investigate the connections between pollution, ecology, and energy sources. There have been numerous attempts to research new, environmentally friendly techniques and overcome the strong reliance on fossil fuels for electricity. Water-based hydrogels offer an excellent opportunity for the creation of sustainable energy systems. With their 3D networks acting as a stable support for encouraging ion and electron transfers in energy devices and as a cutting-edge instrument in water purification, gels can function as creative materials for energy and water technologies in this context.