Hindawi
Journal of Nanomaterials
Volume 2018, Article ID 3692420, 2 pages
https://doi.org/10.1155/2018/3692420

Editorial

Advanced Nanomaterials for Biological Applications

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Received 13 June 2018; Accepted 14 June 2018; Published 29 August 2018

Nanomaterials have been widely studied for many years and they have also generated an intense scientific interest due to a wide variety of potential applications in biomedical, optical, and electronic fields. Nanomaterials have drawn attention based on the few properties they exhibit like their surface to mass ratio and the reactivity of their surface. Also, the control of composition, size, shape, and morphology of nanomaterials is an essential cornerstone for the development and application of nanomaterials and nanoscale devices. The selection of material depends on factors such as (i) required size of nanoparticles, (ii) aqueous solubility and stability, (iii) surface characteristics as charge and permeability, or (iv) degree of biodegradability, biocompatibility, and toxicity.

This special issue holds 3 reviews and 10 original research articles. Various nanomaterials including gold nanoparticles, TiO_2, ZnO, magnetic nanomaterials, graphene, heparin-based nanoparticles, and polymer nanocomposites were used to show their potential applications in multimodal imaging contrast agents, cancer detection, drug delivery, cytotoxicity and genotoxicity, biosensing, antibiofilm, protein binding, and tumor destruction via heating (hyperthermia).

J. Morán-Martínez and coworkers reported the utilization of coating with TiO_2 nanoparticles for the improvement of the characteristics of NiTi archwires and discussed their effect on histopathological, cytotoxic, and genotoxic properties. They have used male rats in four groups with different treatments, and the amount of TiO_2 nanoparticles was changed gradually. Their results showed that cell viability in lymphocytes treated with TiO_2 NPs did not cause genotoxicity. In addition, the histopathological studies of hepatic and renal tissue indicated the nuclear alterations and necrosis.

M. Oves and coworkers contributed with a review on the exosomes for drug development against cancer and other infectious diseases. They have focused on the studies reported in the literature on the application of exosomes in tumor therapy and infectious disease control. In particular, they have highlighted the importance of exosomes in cancer biology and infectious disease diagnoses and therapy and provide a comprehensive account of exosome biogenesis, extraction, molecular profiling, and application in drug delivery.

For the detection of human epidermal growth factor receptor 2 (HER2) protein, E. Villegas-Serralta and coworkers contributed a research article on the magnetic nanoparticles coated by aminosilane and dextran various species and their conjugation with the single-chain variable fragment antibodies (scFvs). Their analyses concluded that aminosilane surface coating enhanced the scFv conjugation efficiency over twofold compared to that of the dextran-coated magnetite NPs for the detection of HER2 proteins. The utilization of magnetic fluid in hyperthermia was presented by H. Mamiya and coworkers in their research article. Magnetic fluid hyperthermia therapy is considered as a promising treatment for cancers including unidentifiable metastatic cancers that are scattered across the whole body. They mentioned that the indicated allowable upper limit of field amplitude for constant irradiation over the entire human body corresponded to approximately 100 Oe at a frequency of 25 kHz. The limit corresponds to the value of 2.5×10^6 Oe·s^{-1} and is

significantly lower than the conventionally accepted criteria of 6×10^7 Oe·s^{-1}. In their research, they focused on the evaluating maximum performance of conventional magnetic fluid hyperthermia cancer therapy below the aforementioned limit using magnetic fluid. Their results showed that the whole-body magnetic fluid hyperthermia treatment is still a possible candidate for future cancer therapy.

M. M. Mahan and A. L. Doiron highlighted the role of gold nanoparticles as X-ray, CT, and multimodal imaging contrast agents in their review. Gold nanoparticles (AuNP) have attracted interest recently for their use as CT CA due to their high X-ray attenuation, simple surface chemistry, and biocompatibility. They have summarized the current state-of-the-art knowledge in the field of AuNP used as X-ray and multimodal contrast agents based on their design specification of particles that includes size, shape, surface functionalization, composition, circulation time, and component synergy. N. Volkova and coworkers also used gold nanoparticles to study the effect of concentrations of gold nanoparticles on the immunophenotype, synthesis collagen type I, ability to direct differentiation, and spectroscopic characteristics of bone marrow mesenchymal stem cells (MSCs). They observed that lower concentration (1.5–9 μg/ml) did not lead to changes in the level of expression of CD 45, CD 90, and CD 73, thus safe for MSCs. However, at particular concentrations of 6 and 9 μg/ml of AuNPs, a decrease in CD 44 cells by 6% and 9%, respectively, was observed.

Y. Zheng and coworkers contributed a research article on the graphene nanoplatelets and their nanocomposites for extracorporeal detoxification. They showed that the graphene nanoplatelets (GNP) can be used as a low-cost alternative hemosorbents for rapid removal of a broad spectrum of proinflammatory cytokine markers, with low cytotoxicity towards the hepatic cell line HepG2. Y. Parcharoen and coworkers also used the family of graphene especially graphene oxide and hydroxyapatite composites electrodeposited on TiO_2 nanotube arrays, and their bacterial stress and osteoblast responses were presented.

N. A. Al-Shabib and coworkers reported in their research article the biosynthesis of zinc oxide nanoparticle using *Ochradenus baccatus* leaves and their antibiofilm activity, protein binding studies, and in vivo toxicity and stress studies. Their studies confirmed that ZnO nanoparticles demonstrated significant biofilm inhibition in human and foodborne pathogens at subinhibitory concentrations. In addition, these nanoparticles demonstrated efficient binding with HSA protein with no change in their structure. Interestingly, in vivo toxicity evaluation confirmed that OB-ZnNPs possessed no serious toxic effect even at higher doses. Moreover, they were found to have excellent antioxidant properties that can be employed in the fields of food safety and medicine.

In summary, this special issue will provide a detailed account of the present status of nanomaterials and highlights the recent developments which cover the novel and important aspects of these materials and their biological applications.

Authors' Contributions

Faheem Ahmed and Ameer Azam are shared first authors.

Acknowledgments

The editors would like to thank all authors who submitted their research to this special issue as well as all reviewers for their valuable contribution.

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