Extended Abstract

Nano Science 2016: Smart organic-inorganic hybrid nanomaterials: Design and functionality - Nekane Guarrotxena - Spanish National Research Council

Abstract

The grouping of the single physical properties (light scattering, emission and absorption, and magnetic response) of inorganic nanoparticles (NPs) with the related chemical structures derivative from the morphology and consequently the microstructure of polymer chains talk by themselves about its key-role played within the development of highly functional nanomaterials and nanocomposites. So far, functional smart polymers are getting increasingly straightforward to style and synthesize multifunctional nanomaterials with an interesting range of predictable responses and other properties. A smart polymer, by definition, can convert energy from one form into another by responding to a change in some stimuli (temperature, pH, mechanical strength, or electric and magnetic fields) in its environment. Therefore, smart polymers are utilized in biotechnology, medicine and engineering, in such applications as drug delivery systems, chemical separation, sensors and actuators. On the idea of the high interest within the scientific community, even when important research has been done along the last years on the effective polymer coating approaches of NPs, the establishment of latest protocols for his or her functionalization remains needed. Within this performance, we would like to attention the current development in their successful integration via multidentate grafting to conjugation which assurances the extremely wanted features, like compact hydrodynamic size, amphiphilic, pH- and thermo-responsiveness, and improved optical properties for future bio- and technological applications of our practical nanohybrid materials. A complete description of those properties is going to be exposed along.

The obvious physicochemical belongings of colloidal nanoparticles (NPs) have complete this class of materials very hopeful for frequent requests overall nano-related fields (science, technology and medicine). These size and shape dependent tuneable properties also can be personalized by surface alteration, functionalization or hybridization with other nanomaterials and/or polymers for specific requests. Functionalization of inorganic nano particles with polymers and/or reasonably intended molecules proposals a pathway towards engineering receptive and multifunctional complex systems. Stimuli-responsive polymer materials respond during an affected thanks to very small variations in their environment (stress, temperature, light, ionic strength, pH, humidity and electric or magnetic fields). So far, practical smart polymers are receiving progressively straight forward to style and manufacture nanomaterials with an motivating choice of expectable responses and other properties. Furthermore, the hybridization of NPs with stimuli receptive polymers control and stabilize their assembly, and in consequence, the symbiosis between both components (nanoparticles and wrapping polymers), may result in smart nanomaterials which combine, change or current novel properties from their individual systems. These materials are

playing an progressively related part during a wide selection of requests, like smart optical systems and devices, micro-electromechanical systems, coatings, biosensors and diagnostics. On the idea of the high attention within the scientific community, even when important study has been done along the last years on the polymer coating of NPs, the formation of new protocols for their functionalization is still desirable. This talk will highlight current advance within the area of multifunctional organic-inorganic hybrid nanostructures that are self-assembled from nanostructured building blocks, that study in the development of nano-hybrids optical responses depending on the impact of pH and temperature external stimuli. The principal development within the field of organic–inorganic hybrid nanomaterials was stimulated by frequent applications in chemistry, physics, life sciences, medicine, and technology. Presently, within the field of hybrid materials, scholars may select either to mimic complex natural materials or to compete with nature by creating new artificial materials. The deep mechanistic understanding and structural insight achieved in recent years will guide a replacement wave within the planning of hybrid materials at the atomic and molecular levels.

Nanomaterials with controllable chemical compositions and structures, large surface-to-volume ratios, various surface properties, and functionalities offer many opportunities for regulating the biological function of incorporated protein1–5withinteresting potential applications in catalysis,6–9drugdelivery,10–13and biosensors.14–17By far, immobilization of protein on to nanomaterials, chemical conjugation of protein with artificial polymers, in place crosslinking of protein with polymers, and self-assembly of protein with organic/inorganic components represent normally used methods to prepare protein-incorporated hybrid bionanomaterials, as dis-cussed in a number of reviews.1,9,18–22The design and synthesis of such hybrid bionanomaterials remain a challenge in terms of tailoring the structures of the bionanomaterials in response to their applications. This review focuses on the recent advances of the preparation methods and structures of functional protein–organic/inorganic hybrid nanomaterials with potential applications to bio catalysis and drug delivery. These newly developed methods are grouped into categories in terms of protein–polymer conjugates, protein–polymer nanogels, and protein-incorporated complex hybrid nanomaterials. The design and synthesis of these materials for drug delivery and enzymatic catalysis are also discussed with reference to the conventionally modified biological molecules.

Hybrid nanomaterials contain two or more different components, typically inorganic components (metal ions, metal clusters or particles, salts, oxides, sulphides, non-metallic elements and their derivatives, etc.) and organic components (organic groups or molecules, ligands, biomolecules, pharmaceutical substances, polymers, etc.) that are brought together by specific interactions which result in the synergistic enhancement of their functional properties. A hierarchy of interactions may be involved in the construction of hybrid materials, from the building of molecules (covalent bonds, π-complexation, etc.) to nanoscale binding and self-assembly (a wide variety of intermolecular interactions, including electrostatic interactions, dispersion interactions, H-bonding, etc.) and micro structuring (cooperative interactions in multiple modes). The combination of different components and structural layouts with different types of interactions results in a virtually infinite variety of unique task-specific materials.

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