Preface

Materials from living matter and inorganic materials are apparently on opposite sides in the materials’ world. In this context, biological materials including polysaccharides, proteins, nucleic acids, and lipids, have soft and flexible natures, and often show incredible functions with high specificity and efficiency, which cannot be easily re-generated or replicated by combination of man-made materials. Therefore, direct use of such a class of biological materials sounds like a rational way to construct highly sophisticated functional systems.

The best way to cope with the high functionality and stability of bio-related materials for practical applications is to create hybrids consisting of materials of biological origin and inorganic materials. However, simply mixing these materials together into a messy slurry is not a wise strategy. In biologically derived materials both components have their own well-organized, meaningful nanostructures, and therefore, hybridization of inorganic and biological elements in controlled structures with nanometer-scale precision is the most desirable strategy. The obtained materials can be called “bio-inorganic nanohybrids.” They are well-blessed children from both worlds, and should succeed in providing essences and advantages of both biological and inorganic materials. Research in bio-inorganic nanohybrids can be defined as an interdisciplinary field resulting from the interfaces between biotechnology, materials science, and nanotechnology. Such a new field is closely related to significant topics such as biomineralization processes, bioinspired materials and biomimetic systems. The incoming development of novel bio-nanocomposites introducing multifunctionality and taking profit from the characteristics of both types of constituents is nowadays an amazing research line taking advantage from the synergistic assembling of biopolymers with inorganic nanosized solids.

Mother of pearl and marine shells, corals, teeth, bones, and microbe inclusions (such as sulfur or iron nanocrystals) are examples of bio-inorganic nanocomposites. In many cases, these composites have biopolymers and inorganic parts organized on the nanoscale, such as the regular alternation of proteins and calcium carbonate nanolayers in nacre. When struck, the layers glide over one another absorbing the shock. If cracks develop, plates simply grow back together. Such natural nanocomposite materials often combine unique mechanical properties based on the nanoscale organization of hard and soft materials and have the ability for regeneration.
and self-reproduction. However, these nanocomposites have a fatal drawback in their application. In most cases, their functions are optimized only at ambient conditions and their structural stability is maintained in a limited environment. In contrast, inorganic materials usually have incredible stability and stiffness, even in extreme conditions. In addition, they sometimes offer us the opportunity to prepare precise structures by both top-down fabrications and bottom-up assembly. Of course, superior aspects in electronic, photonic, magnetic, and mechanical properties can be expected in many inorganic materials. Nevertheless, no one can believe that the highly sophisticated functions seen in living systems may be constructed by assembly and fabrication of materials of exclusively inorganic nature.

The focus of this “Bio-Inorganic Hybrid Nanomaterials” book is to cover the wide spectrum of recent developments in natural and artificial bio-hybrid materials, which is the result of the successful assembly of 15 chapters by world-wide experts in their corresponding fields. Fundamental aspects on the preparation of bio-inorganic nanohybrids using various nanostructures including mesoporous materials, nanoparticles, gels, organoclays, membranes, and nanotubules with advanced methodologies such as the sol–gel process, self-assembly, intercalation, template synthesis and layer-by-layer adsorption upon the concept of supramolecular chemistry, biomimetics, and biomineralization are thoroughly described. Not limited to basic sciences, several chapters introduce practical applications of bio-inorganic nanohybrids, as exemplified in biodegradation, bone tissue re-generation, controlled delivery, and enzymatic activity. Readers can enjoy independent chapters and also feel the good harmony of the balanced assembly of the chapters. We hope that every reader can find potential possibilities of bio-inorganic nanohybrids with certain wonder, surprise, and impression, just after closing these pages.

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