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Editorial

Controlling the Length Scale through "Soft" Chemistry: From Organic–Inorganic Nanocomposites to Functional Materials

The field of Organic–Inorganic Nanocomposite Materials has been widely recognized as one of the most promising and rapidly emerging research areas in Materials Chemistry. We can perhaps best describe these systems as being organized into spatially identifiable domains of an organic and an inorganic component. They are generally produced using various methodologies of "soft" inorganic chemistry (chimie douce) in liquid or sol/gel media, exploiting either self-assembly mechanisms under the influence of structure-directing agents (templates), controlled polymerization processes in such media, or directed assembly of nano building blocks in solution or at liquid/solid interfaces. A general classification has been proposed (Sanchez, C.; Ribot, F. *New J. Chem*. **1994**, *18*, 1007), distinguishing "class I materials", in which the inorganic and organic components interact only weakly through hydrogen bonding, van der Waals contacts, or electrostatic forces, from "class II materials", in which the constituents are more strongly linked through ionic/covalent bond formation. The spatial organization of dissimilar and commonly incompatible components in these hybrid materials produces a wealth of novel structural features, physical properties, and complex functions, which arise from the synergistic interaction of the individual constituents. Promising applications are expected or have already been realized in many fields of technology, optical and electronic materials, solid electrolytes, coating technology, sensorics, catalysis, and separation science, among others. Harnessing the potential of organic–inorganic nanocomposite materials requires fine-tuning of the sizes, topologies, and spatial assembly of individual domains and their interfaces. This, in turn, relies on perfecting chemical routes of covalent attachment coupled with an improved fundamental understanding of self-assembly mechanisms, particularly those involving weak intermolecular forces. Further, elucidation of organization at the nanoscale, and the macroscopic properties that ensue, demand continual advancements in structural characterization and modeling.

The purpose of this Special Issue is to showcase recent progress in this multifaceted field. A number of "short reviews", written by many of the most distinguished research leaders, summarize the current state-of-the-art and identify key challenges in the future development of advanced materials based on hybrid architectures. This Special Issue also contains many original contributions, highlighting exciting new forays and recent achievements in hybrid materials, including those derived from inorganic nanoclusters and polymers, thin films and functionalized interphases, materials achieved through topochemical reactions of molecular or polymeric guests with layered inorganic hosts, and two- or three-dimensional inorganic nanocluster/polymer arrays and bio-doped systems. This volume also includes contributions in the continually growing area of biomineralization wherein inorganic phases nucleate and grow at the surfaces of biological/organic monolayers, thin films, or nanospheres. Biomineralization can produce highly organized nanocomposite structures, and considerable attention has been devoted to the mechanisms of biological control over morphogenesis in such

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systems. Understanding biomineralization at a fundamental level may also be of key importance for developing specific architectures over extended length scales for a wide range of inorganic materials. Several contributions here illustrate an approach that has been described as "nanotectonics" (see short review by Davis et al., this issue), wherein novel approaches relying on bio-inspired synthesis and assembly of nano building blocks allow the design of complex architectures. Though the majority of the articles in this issue focus on fundamental advances in synthesis, structure, and mechanistic control, the achievement of functional materials, particularly in optical and electrical devices, are on the horizon. The reader will find several articles that address hybrid materials with physical and chemical properties that promise new leaps in technology.

Before closing, we would like to acknowledge those without whom this issue would not be possible. To the authors of "short reviews", we are most grateful for your efforts in molding a vast amount of current knowledge into a cohesive conceptual picture. To all of the contributors of original papers, we wish to thank you for submitting your most exciting work. Furthermore, the dedicated scrutiny, the thoughtful criticism, and the balanced judgment provided by our reviewers has been extremely valuable for securing the highest scientific standards possible. We know your time is precious and we wish to express our sincere gratitude for your excellent service! Finally, we wish to thank the staff members in Columbus, OH, Minneapolis, MN, Muenster, Germany, and Troy, NY, for your patience and dedication in handling truckloads of paperwork, manuscripts, and correspondence. Without your devotion this Special Issue would never have been possible.

Unfortunately, this Special Issue can only provide a snapshot of a research field that is on a very fast trajectory, and it is not unlikely that some contributions will be leapfrogged by newer ones by the time the issue is printed. Nonetheless, we believe that the issue will serve as a useful reference and benchmark for future work in this area while stimulating the exchange of ideas among different research perspectives that is so vital to advances in Materials Chemistry.

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