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Editorial

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Self-assembled nanostructures and materials: smart and bright!

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Self-assembly is a widely observed phenomenon in the natural world, where building blocks (e.g., small molecules, macromolecules, colloids, macroscopic particles, etc.) are synergistically organized through multiple weak interactions to form dynamic multi-component assembled systems in a programmable and controllable manner[1-3]. This enables the creation of various nanostructures and materials with tailored properties and complex functions. The development of artificial molecular assembly and biomimetic assembly research can provide new methods and tools for investigating and understanding thermodynamics and kinetics of self-assembled processes. By deeply understanding self-assembly at the molecular level, researchers step forward to fabricate self-assembled nanostructures or materials with desired geometries and properties, which provide more opportunities for high-performance applications, such as therapy, imaging, energy harvesting, catalysis, signal dynamics regulation, and so on[4-6]. Through elaborate design of molecules or building blocks with desired structural parameters and optimization of experimental conditions to control assembled pathways, various materials with advanced and improved functions could be envisioned.

The Special Issue is focused on the recent progress of self-assembly structures or materials in broad interdisciplinary areas, which involve organic/inorganic chemistry, polymer chemistry, colloid and surface chemistry, nanotechnology, soft materials, and material science. Recently, many scientists have developed self-assembled systems based on biopolymers, such as DNA, proteins, and polypeptides, as well as other natural or synthetic biopolymers[7,8]. For example, Zhong *et al.* utilized the dynamic and exchangeable

nature of DNA hydrogen bonding to build a series of artificial dynamic nucleic-acid-based networks[9].Their review highlights the potential of DNA networks for mimicking biological transformations and addresses the challenges of building dynamic networks with life-like behavior in cell-like confined environments. Apart from supramolecular DNA-based nanotechnology, Sun *et al.* summarized the recent advances in host-guest assemblies for enhanced photothermal therapy[10]. Taking advantage of the dynamic features and unique microenvironments of host-guest complexes, we discussed improved photothermal efficiency, enhanced distribution at target cancer sites, and multimodal therapy. This opens an alternative avenue for high-performance biomedical applications. Recently, Mao *et al.* developed copper-based chalcogenides with well-controlled electrical and optical properties, demonstrating huge opportunities for biomedical and clinical applications[11]. Besides utilizing the self-assembly concept in biomedical areas, different self-assembled materials with porous structures have emerged for water harvesting[12]. By designing and tuning the pores and exo- or endo-sites of porous materials, the interactions between adsorbents and water can be well regulated; thus, water absorption into such materials is achieved in an efficient way. Another example reported Pd nanoclusters anchored on carbon support for heterogeneous catalysis, which indicates superior catalytic activity of ultrasmall Pd nanoclusters[13].

The above-mentioned examples highlight the significant potential of self-assembly chemistry in boosting elaborate design and synthesis of advanced supramolecular systems. We hope to stimulate further endeavors to create materials that have not yet been possible in the synthetic world and to fully explore their potential in diverse applications.

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