Self-organization is emerging as a key concept in many disciplines including physics, chemistry, biology, mathematics, and even social sciences. With respect to this notion, one may have a different aspect depending on area of his/her expertise. In the fields of chemistry and materials science, self-organization is often used almost interchangeably with self-assembly, which, in a precise sense, represents a process, where certain components in a disordered state form an ordered structure or pattern under thermodynamic control without intervention of external forces. In conjunction with advances in nanoscience and nanotechnology, design of nanostructured materials using molecular self-assembly has attracted growing attention since it allows for the formation of complex architectures with a high structural precision at a molecular level. Due to its reversible nature, molecular self-assembly most likely gives rise to a thermodynamically stable, defect-free structure. Such so-called “soft materials” is expected to not only provide new catalysis, sensors, and biomaterials, but also serve as alternatives to conventional inorganic materials for the development of lightweight and flexible electronic devices.

Here we will focus on controlled synthesis of self-assembled nanomaterials formed from different types of molecular building blocks. First, we will show an overview of molecular self-assembly by taking low-molecular weight systems as an example. In such systems, through elaborate design of building blocks by organic synthesis, functional groups and intermolecular interactions for structuring are pre-programmable into a building block, so that the resulting assembly exerts particular properties. This approach to create nanostructures is referred to as “bottom-up” in contrast to “top-down” technique represented by lithography. Concerning self-assembly of polymeric systems, Professor Yabu will present the development of very unique polymer nanoparticles, whose inner structures can be controlled by phase separation of block-copolymers and polymer blends. His talk will also include applications of the polymer nanoparticles combined with inorganic nanoparticles. Dr. Durand will describe interesting approach for the functionalizations of inorganic surfaces with self-assembled monolayers, which allow integration of peptide and functional molecules for biological applications. Through discussion with researchers in different fields, we would like to find new aspects and future directions that have hardly been realized by experts of this field.