Frontiers in Supramolecular Design of Materials

The powerful functions of materials in the living world utilize supramolecular systems in which molecules self-assemble through noncovalent connections programmed by their structures. In materials chemistry this strategy as a design tool for novel materials is now developing rapidly and has been the focus of our laboratory over the past few decades. I will discuss in my lecture three examples of molecularly designed materials we need for our future. The first is inspired by the photosynthetic machinery of green plants, creating materials that harvest light to produce fuels for sustainable energy systems. The second example describes “robotic materials” in which a light-activated chemical reaction and magnetic fields transduce energy into locomotion and muscle-like mechanical actuation. The third topic will be supramolecular biomaterials that mimic extracellular matrices and provide unprecedented bioactivity to regenerate tissues. In this example, I will discuss a recent breakthrough on the use of covalent structure to control supramolecular motion, which surprisingly led to biomaterials with potential to reverse paralysis after severe injury by repairing the brain and the spinal cord.