Supramolecular Assembly Materials for Next-Generation Energy Storage Applications

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Gradual increment of primary energy demand and consumption in building sectors has become a major concern over time. ~50% of the entire building's energy is consumed just to improve the quality of living comforts like indoor cooling, ventilation and artificial lighting of interior places etc. To reduce the building energy load, my research has focused on the Electrochromic (EC) smart-window technologies, which can dynamically regulate solar heat and light transmission, thereby maintaining comfortable indoor temperate and visual conditions without extra power. We employed organic-metallic supramolecular polymers (MSPs) as an active EC material for the EC device/window fabrication.[1] MSPs exhibit distinct characteristics charge-transfer bands in the visible or NIR spectral range, which can be reversibly modulated through redox process. Our research has primarily focused on the molecular design of MSPs and the optimization of device fabrication techniques to enhance both performance and long-term stability. For instance, we found that when the polymer chain entanglement in 1D-Fe(II)-based MSP was removed by making a composite with polystyrene polymer,[2] or preparing 2D MSP-nanosheet [3] significantly accelerated ion-transfer in the film, leading development of ultra-fast EC device. On the other hand, incorporating a suitable counter electrode material resulted in a remarkable enhancement in device durability. [4]

In my current study, I have extended my research to next-generation energy-storage technology, with a specific focus on hydrogen storage, while keeping my research background in supramolecular assembly as a foundation. The storage of hydrogen is key to its applications. Developing adsorbent materials with high volumetric and gravimetric storage capacities, both of which are essential for the efficient use of hydrogen as a fuel, is challenging. To address this challenge, we are exploring porous crystalline materials, such as metal-organic frameworks (MOFs), which offer promising architectures for hydrogen adsorption.[5] In the last part of my presentation, I will introduce my past and current research and future prospects.

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