Nanomaterials for Energy Storage, Catalysis, and Sensors

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Due to the increase in the use of renewable energy whose supply is unstable, energy storage has been an important issue worldwide. In addition, to solve the increasing environmental pollution problems, efficient catalysts and decomposition technique are required. To keep the health of human beings, sophisticated materials and methods need to be designed to monitor the level of hazardous materials in human body. Therefore, to satisfy these requirements, nanocomposites have been developed based on carbon materials such as graphene, carbon nanotubes, and carbon fibers. These carbon structures enhance the conductivity and surface area of the electrodes for supercapacitors and sensors and of the catalysts and photocatalysts. To overcome the limitation in the capacitance of the carbon materials, metal oxides and sulfides have been investigated to enhance energy density in the supercapacitors. Nanomaterials based on metal oxides or sulfides have also been studied as catalysts and photocatalysts with the help of graphene to promote their performance. Their large surface area and high electrical conductivity improve the overall electrochemical performances tremendously owing to the synergistic effects of their excellent conductivities of graphene and high electrochemical properties of metal oxides or sulfides.

In our lab, carbonaceous materials such as graphene, carbon nanotubes, carbon nano-onions and various mono-, binary-, and ternary-metal oxides or sulfides have been combined to make nanocomposites for energy storage, catalysis, and sensing analytes. Doping of sulfur or nitrogen has also been investigated to get higher performances.