Shaping and Manipulating Plasmonic Nanomaterials for Applications Including Photocatalysis

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Plasmonic nanomaterials are known to be well suited for light harvesting. We have combined the nanomaterials with semiconductor and exploited energy of the captured photons for separating positive and negative charges (JACS, 2005, 127, 7632). This effect, plasmon-induced charge separation (PICS), has been applied to photovoltaics and photocatalysis (Chem. Sci., 2017, 8, 3325).

One of the advantages of plasmonic nanomaterials is that they are easy to manipulate in size and shape, and through the manipulations, plasmonic properties can be controlled. For instance, light absorption efficiency can be improved by increasing the particle size. However, as the particle size increases, the PICS efficiency could be lowered. So we electromagnetically coupled a small nanoparticle with a large nanoparticle, so that high PICS efficiency and high light absorption efficiency were achieved simultaneously (JPCC, 2020, 124, 23454).

We also shaped plasmonic nanocomposites by taking advantage of a hole ejection process involved in PICS. Gold nanocuboids were irradiated with circularly polarized light (CPL) in the presence of lead(II) ions, and chiral nanocomposites consisting of gold and lead oxide were fabricated (Nano Lett., 2018, 18, 3209). The handedness of the nanocomposites can be inverted by UV light irradiation followed by opposite CPL irradiation (ACS Nano, 2020, 14, 3603). Some other applications of plasmonic nanomaterials including smart windows will be presented.