Gold Nanoparticles Speed Up Photocatalysis

Boosting renewable energy and combating climate change are crucial scientific goals, but one common roadblock is how to effectively store solar energy once it’s been harvested. One way around that roadblock is hydrogen.

Researchers from Rutgers University, USA, have now found a nanotech-driven way to dramatically boost the efficiency of photocatalysis.

Boosting photocatalysis

TiO_2 is a desirable semiconductor for photocatalysis because of its abundance, low cost, stability, and well-aligned valence and conduction bands. But because of its large band gap, TiO_2 can use only UV radiation to drive water-splitting reactions. The Rutgers team, led by engineering professor Laura Fabris, wanted to see if there were ways to tap a larger slice of the solar spectrum.That energy concentration results in a local surface plasmon resonance (LSPR), with intense local electric fields. Those intense fields, in turn, can enhance the formation of excited or “hot” electrons that can boost photocatalysis rates in the semiconductor.

A (nano)star is born

The researchers' modeling suggested that the long spikes of star-shaped nanoparticles, which generate intense electric fields at their tips when illuminated with visible and near-infrared (NIR) radiation, were the most promising candidates for plasmonic hot-electron generation under sunlight. The team developed a method for synthesizing such nanostars without a surfactant, which allowed a shell of TiO_2 to be grown directly onto the gold surface, facilitating efficient electron transfer between the nanostars and the semiconductor. An added bonus is that, since their shape can be modified to change the number of points and dimensions, nanostars allow for predictable tunability of the LSPR bands from the visible to the NIR.

Low-temperature process

The researchers found that a simple, low-temperature, sol-gel approach worked best to synthesize and tune the TiO_2-coated nanostars. The low temperature preserves the delicate morphology of the particles. "We were also able to use very low temperature synthesis to coat these gold particles with crystalline titanium, Fabris explained in a press release. "I think both from the materials perspective and the catalysis perspective, this work was very exciting all along."

For more information: doi: 10.1016/j.chempr.2018.06.004