U-M researchers working toward efficient harvesting of solar energy

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At the University of Michigan College of Engineering, recent breakthroughs may lead to more effective means for harnessing the power of the sun.

Conventional means of collecting solar energy, solar cells for example, have been notoriously inefficient.

Now a team of chemical engineers at U-M is exploring new means of exploiting the abundant energy produced by Earth's nearest star. They have discovered a method for utilizing metal nano-particles, which act much like nanometer-sized light antennae, to help accelerate the production of renewable solar fuels and other chemicals.

The team, led by chemical engineering professor Suljo Linic, includes doctoral students David Ingram, Phillip Christopher and Hongliang Xin.

"The diffuse nature of solar light makes it very difficult to design processes that can convert the energy of sunlight into energy of chemical bonds at high rates," Linic said. "Our recent work shows that by using nano-particles with tailored optical properties, we can efficiently concentrate light and convert its energy into chemical energy at higher rates."

Two important findings from the team's research have recently been published in leading chemistry journals. The first article, published in *The* Journal of the American Chemical Society, is titled "Water Splitting on Composite Plasmonic-Metal/Semiconductor Photoelectrodes: Evidence for Selective Plasmon-Induced Formation of Charge Carriers near the Semiconductor Surface." In it the team explores the use of silver nano-antennas to enhance the ability of a semiconductor catalyst to generate hydrogen fuel from water using solar energy.

The second paper, "Visible light enhanced catalytic oxidation reactions on plasmonic silver nanostructures," and published in Nature Chemistry, points out that currently all important industrial chemical reactions are driven by thermal energy, requiring massive fossil fuel inputs. Linic and his team have developed technology where a significant fraction of energy input to drive chemical reactions can be provided in the form of solar energy. This discovery paves the way toward a more environmentally friendly chemical industry using the power of the sun.

The research is funded by The National Science Foundation (NSF) and the Camille Dreyfus Teacher-Scholar Award from the Camille and Henry Dreyfus Foundation.

The university is pursuing patent protection for the intellectual property, and is seeking commercialization partners to help bring the technology to market.

More information: Water Splitting on Composite Plasmonic-Metal/Semiconductor Photoelectrodes: Evidence for Selective Plasmon-Induced Formation of Charge Carriers near the Semiconductor Surface, J. Am. Chem. Soc., 2011, 133 (14), pp 5202–5205 DOI: 10.1021/ja200086g

Abstract
A critical factor limiting the rates of photocatalytic reactions, including water splitting, on oxide semiconductors is the high rate of charge-carrier recombination. In this contribution, we demonstrate that this

issue can be alleviated significantly by combining a semiconductor photocatalyst with tailored plasmonic-metal nanostructures. Plasmonic nanostructures support the formation of resonant surface plasmons in response to a photon flux, localizing electromagnetic energy close to their surfaces. We present evidence that the interaction of localized electric fields with the neighboring semiconductor allows for the selective formation of electron/hole (e^-/h^+) pairs in the near-surface region of the semiconductor. The advantage of the formation of e^-/h^+ pairs near the semiconductor surface is that these charge carriers are readily separated from each other and easily migrate to the surface, where they can perform photocatalytic transformations.

Provided by University of Michigan

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