

Researcher pursues new applications for 'hot' electrons

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Three years after his discovery of porous gold nanoparticles—gold nanoparticles that offer a larger surface area because of their porous nature—a University of Houston researcher is continuing to explore the science and potential applications.

Wei-Chuan Shih, associate professor of electrical and computer engineering, will use funding from the National Science Foundation to study electron oscillation in the nanoparticles and develop ideas for harnessing it.

"We can generate hot electrons by shining [light](#) on these nanoparticles, so we are trying to take advantage of that, trying to find a way to make them work," Shih said.

His lab, the NanoBioPhotonics Group at UH, has explored how porous gold nanoparticles react to light for several years; last spring he reported that the light-converted heat can be used to kill bacteria. Last month they described in *Nano Letters* the first time surface (plasmon)-enhanced near-infrared absorption had been demonstrated for chemical detection and identification.

Light at specific wavelengths "excites" the electrons, or spurs them into movement, he said. Taking advantage of the energy generated by the moving electrons involves measuring what occurs over tiny fractions of time: Once the nanoparticle is struck by light, the electrons are set in motion within a few femtoseconds, or one quadrillionth of a second. The

electron oscillation begins to convert to heat after a few picoseconds, or one trillionth of a second.

"It is the hot electrons within the first few femtoseconds that we would like to harvest," Shih said.

Under the NSF grant, Shih said researchers in his lab will study whether the [hot electrons](#) can be used to enhance a catalyst that drives [chemical reactions](#) and boosts signaling. He will work to enhance that signaling and determine ways to use it.

"There is some evidence to suggest plasmonic resonance can promote catalytic reactions," he said of the interaction of light and the nanoparticles. "The light excites these electrons to oscillate within the nanoparticle." Plasmonic resonance describes the way electrons in a piece of metallic nanomaterial react to light, and Shih said it happens only at certain wavelengths.

Research to speed chemical reactions can have huge payoffs in the oil or petrochemical industry, as small improvements can yield large impacts. But Shih is focused on biosensing, using the chemical reactions to produce a stronger signal from tiny targets, more quickly.

"We are interested in ultrasensitive detection of disease, including cancer biomarkers such as nucleic acids and proteins," he said.

Learning to better amplify the signal could have a number of applications. Shih noted that enzyme-linked immunosorbent assay, or ELISA - an analysis commonly used to measure proteins in research labs - depends on a catalysis reaction to boost the signal. Discovering a way to improve the efficiency of the method would have broad consequences, just one example of how the work could be useful, he said.

Provided by University of Houston

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