



By patterning a solar absorber with tiny holes with diameters less than 400 nanometers, an MIT-Masdar Institute team has enhanced the range of solar energy that the device can absorb. Here, Masdar Institute postdoc Jin You Lu characterizes the nanoporous solar absorber using UV-Vis-NIR spectroscopy.

Photo: Tahra Al Hammadi/Masdar Institute News

## New solar absorber could improve efficiency of solar thermal technology

Masdar Institute-MIT team develops device that harnesses more sunlight, enhancing efficiency of heat production.

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*The following is adapted from a Masdar Institute article by Erica Solomon.*

A team of researchers at MIT and the Masdar Institute of Science and Technology has discovered a low-cost way to significantly increase the amount of solar energy that can be converted into heat, via a device called a solar absorber. This advance should help make sustainable technologies that rely on solar heat more efficient and affordable.

“Our research team has developed a simple and cost-effective fabrication technique to create solar absorbers that can harness a greater share of the solar spectrum, thus increasing their efficiencies, while also maintaining low emission levels,” says TieJun Zhang, assistant professor of mechanical and materials engineering at the Masdar Institute, a graduate-level engineering university in the United Arab Emirates.

Zhang co-authored the paper that describes this research, which was published this month in the journal *Advanced Optical Materials*. The work contributes to a larger Masdar Institute-MIT research project, which is aimed at developing a solar-powered combined electrical power plant and cooling system.

The MIT and Masdar Institute Cooperative Program helped launch the Masdar Institute in 2007. Research collaborations between the two institutes address global energy and sustainability issues, and seek to develop research and development capabilities in Abu Dhabi.

Nicholas X. Fang, professor of mechanical engineering at MIT and co-principal investigator of the project, said: “We are very excited that this MIT-Masdar Institute collaboration has led to new insights in the emerging field of plasmonics, which quantifies the interactions between the electromagnetic field and free electrons in a metal. By trapping sunlight with plasmonics, the solar absorber developed by our team can achieve higher efficiency levels. We look forward to testing the overall solar conversion efficiency of the coating materials in the next step of our research.”

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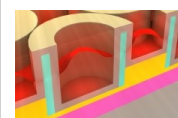
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The team's novel fabrication technique involves patterning a solar absorber with tiny holes with diameters less than 400 nanometers — roughly 1/200 the width of a human hair — cut into the absorber at regular intervals.

The tiny holes penetrate the entire absorber, greatly enhancing the range of solar energy that can be absorbed. Close to 90 percent of all the wavelengths of light that reach Earth's surface are absorbed by the device. Unlike traditional solar absorbers, this absorber requires very little material and consists of only two layers: a semiconductor film and a reflective metallic layer, with a total thickness of 170 nanometers.

"This idea can be applied to most conventional solar absorbers. With this unique patterning, the absorbers can be boosted to harvest more solar energy from the ultraviolet and visible regions of the electromagnetic spectrum," says Masdar Institute postdoc Jin You Lu, the paper's lead author along with MIT postdoc Sang Hoon Nam.

To optimize a solar absorber's efficiency, it is desirable to maximize the solar absorption and reduce the thermal radiation of heat from the absorber. However, it is challenging to create a solar absorber that can absorb a high level of sunlight while maintaining low thermal radiation losses. As the solar absorber takes in more energy, its temperature increases, causing it to lose energy in the form of thermal radiation.

The sweet spot of a solar absorber then, is that point when optimal levels of sunlight are absorbed with the least amount of energy escaping back into the atmosphere through radiation. Lu believes they may have found this sweet spot.

"By taking advantage of the ultrathin film coatings and patterning, we are able to maximize the absorption spectrum while keeping the solar absorber's emission levels quite low," Lu explained.

The team is now working to optimize the system with alternative metals such as aluminum, copper, or silver, for the reflective metallic layer, which will reduce the costs of the solar absorber even further.

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