SUSTAINABILITY

Looking at Light

RICHARD OSGOOD

Higgins Professor of Electrical Engineering and Professor of Applied Physics and Applied Mathematics

Sometimes, to solve big problems, you have to think small. Richard Osgood thinks very small. One of the biggest energy questions today is how to make solar cells more efficient and more affordable. This is particularly important for the billion or so people who live in poverty and, in most cases, entirely off the grid.

Osgood and the other members of the Surface Group in his Research Laboratory for Fundamental and Applied Science study the basic processes that allow some materials to convert light to electricity. It is a phenomenon that makes photovoltaic cells and fuel cells possible and that lays at the foundation of many hopes for a more sustainable future. But for all its promise, the process is surprisingly not well understood.

"This is a very basic question we're trying to address," said Osgood. "We need to know more about the fundamentals that limit the efficiency of charge transfer."

He and his team use ultra-short bursts of laser light to watch individual molecules of titanium dioxide accept or reject electrons. They also have made some of the first studies of titanium dioxide nanoparticles using the atomic-level resolution of a scanning tunneling microscope (STM) to understand how these novel structures can be used to improve solar cells.

Titanium dioxide is of particular interest because it is used in Graetzel cells, a type of low-cost photovoltaic cell that is easy to manufacture from readily available materials. Most low-cost cells are sensitive to only a narrow band of sunlight. The Graetzel cell, however, contains a layer of organic dye that produces free electrons from a wide spectrum of sunlight, much like chlorophyll does in plants.

The trouble is, Graetzel cells are only about seven to 10 percent efficient, meaning that, at best, only one out of 10 free electrons produces a current. Osgood and others would like to improve on this, but the reasons why one electron is captured and another is not remain elusive. Observing short bursts of laser light at a titanium dioxide crystal with an STM, Osgood and his team are nearing the ability to observe individual electrons being taken up or rejected by the crystal matrix.

Osgood hopes that, by focusing on the small stuff, answers to the big questions are not far off. "The world is changing in the way things are done," he said. "The number of people doing interdisciplinary work is growing every day. It's an exciting time."

B.S., U.S. Military Academy, 1965; M.S., Ohio State University, 1968; Ph.D., Massachusetts Institute of Technology, 1973