Collecting Solar Energy with Nanomaterials

TONY HEINZ

David M. Rickey Professor
of Optical Communications
and Professor of Physics

The amount of energy from the sun that falls to the earth far, far exceeds our demand for energy. Sunlight would surely be of broad use in today's world if we could capture and convert it into electricity sufficiently, efficiently, and economically. The conversion of light to electricity is carried out in photovoltaic devices or, as they are known more commonly, solar cells.

These devices are typically made from silicon. Silicon, the basis for electronic circuits, is in many ways an excellent material. However, the basic properties of electrons in silicon imply that more than two-thirds of the incident energy will necessarily end up as heat rather than as electricity. Is there a way to avoid this energy loss and increase the efficiency of photovoltaic devices?

Tony Heinz is working to revolutionize our understanding of energy-conversion processes and the practical production of electricity from sunlight. He is exploring a new energy-conversion process, in which a single absorbed photon creates two or more electronic excitations. This process, Multiple Exciton Generation (MEG), is weak in conventional semiconducting materials, but Heinz is convinced that it will work with the right materials—novel nanoscale materials.

Heinz and his collaborators are making such structures—individual nanoscale photovoltaic devices based on carbon nanotubes and other tailored nanoscale materials—in which these ideas can be rigorously tested. He said that both the electrical and optical measurements require experimental advances. The program builds on recent progress in extracting photogenerated charges from individual carbon nanotubes and indirectly measuring the amount of light absorbed by such tiny structures through the use of new laser-based techniques.

"This is a very exciting fundamental scientific issue that goes to the core of understanding how light interacts with electrons in solids," said Heinz. "At the same time, it is a problem with the potential to have an important impact on addressing the world's needs for sustainable energy.

"As part of the Energy Frontier Research Center recently established at Columbia University with the support of the U. S. Department of Energy, we have the good fortune of being able to pursue these fascinating questions," he said. "At Columbia, we also benefit from an excellent collaborative research environment. This allows us to bring together the diverse expertise in science and engineering disciplines that is indispensible for progress in attacking these demanding problems."

B.S., Stanford, 1978; Ph.D., University of California-Berkeley, 1982