Material scientist exploring ways to improve efficiency of solar cells

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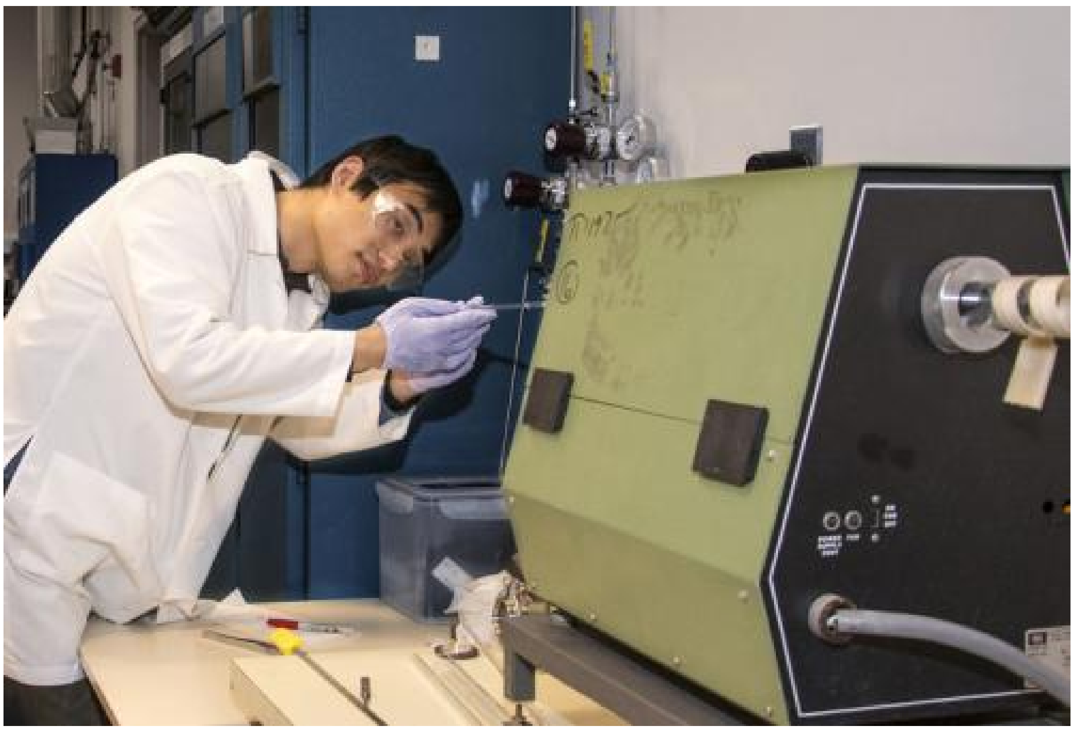

Xiaotian Zhang, an undergraduate student in materials science and engineering, removed a sample of silicon diselenide from an annealing furnace. The researchers are investigating the use of semiconductor crystalline silicon diselenide (SiSe2) as a thin film to sit atop a more conventional silicon solar cell. They are exploring how best to synthesize the material into a thin film as well as how to treat or "dope" it with other elements to improve its photovoltaic qualities. Credit: Justin Wheeler

Sunlight is the earth's most abundant source of energy and if harvested efficiently could be a source of clean, unlimited, renewable energy. According to the United States Department of Energy, world demand for energy is projected to more than double by 2050 and to more than triple by the end of the century. Solar cells, also known as photovoltaic cells, convert sunlight directly into electricity and have tremendous potential to help meet the world's future energy needs but the cost and efficiency of current solar cells hinders them from being a feasible mainstream source of energy.

Joan Redwing, a materials scientist in Penn State's College of Earth and Mineral Sciences, is researching a specialized category of solar cells – referred to as "tandem" solar cells – that have the possibility of increasing, perhaps even doubling the efficiency of solar cells.

Photovoltaic cells basically convert electromagnetic energy in the form of sunlight to electrical energy. Cells typically are made up of a layer of semiconducting material, usually silicon. When sunlight strikes the cell, some of it is absorbed and the energy from the absorbed light knocks electrons free from the semiconductor material. Electricity is generated when the free electrons are captured.

Redwing explained, "The objective of tandem, or stacked, cell technology is to absorb more of the light reaching the cell's surface. In order to capture more of the incoming light, different semiconductor materials that can absorb different parts of the visible light spectrum are stacked in multiple layers on top of each other. By capturing more parts of the solar spectrum, the conversion efficiencies can be improved."

Close-up of silicon diselenide prepared by congruent melting inside a sealed quartz ampoule. Credit: Justin Wheeler

Redwing is collaborating with researchers Chito Kendrick, Adele Tamboli and Eric Toberer from the Colorado School of Mines and the team is investigating the use of semiconductor crystalline silicon diselenide (SiSe2) as a thin film to sit atop a more conventional silicon solar cell. They are exploring how best to synthesize the material into a thin film, as well as how to treat, or "dope," it with other elements to improve its photovoltaic qualities.

"We're interested in using SiSe2 because it has a 'band gap' of about 1.7 eV," says Redwing. The band gap – the amount of energy, expressed in electron volts (eV), needed to be overcome before the semiconductor will conduct electricity – of a typical solar cell made from crystalline silicon is relatively low at about 1.1 eV, which means much of the higher energy photons in sunlight are lost as useless heat. "With a higher band gap, SiSe2 can more effectively absorb the higher energy photons, which increases the efficiency of the solar cell."

The team of researchers recently received one of four grants awarded by the Research Corporation for Science Advancement (RCSA), through its Scialog Collaborative Innovation Award program, to support the tandem solar cell research.

In RCSA's announcement on Feb. 14, President Jack Pladziewicz said, "The goal of RCSA's Scialog (short for science dialog) initiative is to get top scientists talking to one another in hopes of accelerating breakthrough discoveries in areas of major global concern."

Redwing believes, "If we can efficiently harness solar energy through this next generation of solar cells, we will virtually have an unlimited supply of energy."

Provided by Pennsylvania State University