

SUCCESS STORY: PLASTIC SOLAR CELLS PROVE THEIR FLEXIBILITY



Alan Heeger and the pursuit of low-cost organic photovoltaics

THE SITUATION

Solar panels are getting cheaper, but the price isn't dropping fast enough to spur widespread adoption of the technology. And although many U.S. states are setting ambitious goals for renewable energy, these sources account for only about 10 percent of total U.S. energy generation. Solar represents a mere 0.08 percent. Meanwhile, electricity demand continues to grow, expected to increase 28 percent by 2035. If solar is going to be a significant player, major breakthroughs in the technology are essential.

THE CHALLENGE

Organic photovoltaics (OPV), made from plastics and photo-sensitive inks, could completely change the solar equation and help put the world on a sustainable energy path. Organic solar cells have much to offer. They're cheap, flexible, transparent, lightweight, and sturdy. These amazing characteristics have made OPV a booming area of research.

One of the most promising technologies, bulk heterojunction cells (BHJ), was pioneered by Institute faculty member and Nobel Laureate Alan Heeger. His interest in what the sun can do may have been in the cards. Born on a bitterly cold day in Sioux City, Iowa

during the Great Depression, Heeger eventually found his way to sunny California, studying physics at UC Berkeley and later joining UC Santa Barbara. For more than 30 years he has relentlessly pursued advances in the field of conducting polymers, earning the Nobel Prize in Chemistry for his breakthroughs in 2000.

Heeger's BHJ cells combine the charge-making and charge-absorbing materials into a single layer capturing a range of benefits, including low, room-temperature manufacturing and the ability to be printed on flexible substrates. And to make them commercially viable, researchers are leveraging cutting-edge physics and chemistry.

THE OBSTACLES

So what's keeping organic solar from starting a renewable revolution? It turns out, the disordered structure of the BHJ cells doesn't allow electrons to move as freely as in a crystalline structure such as silicon. Any successful implementation of organic solar cells requires that the charge produced be turned into usable energy before it dissipates. Another tricky issue has been getting consistent results, with batch-to-batch variation being too high for reliable manufacturing.

THE BIG IDEAS

The biggest challenge is ensuring that the electrical charge created gets used before it dissipates. Researchers have demonstrated that it is possible to get all of these energy “carriers” out, but doing so in a manufacturing setting is much harder. Heeger’s team, including Professor Gui Bazan, has been able to significantly improve the efficiency of their BHJ cell by carefully controlling the chemistry used to make the conducting layer.

Next, the researchers discovered that tiny amounts of impurities have enormous impacts on solar cell performance. Heeger says, “It kills the device.” So even though the structure is less ordered than for silicon cells, quality must still be very high. By weeding out the impurities, Institute researchers were able to obtain much more reliable results, clearing a crucial hurdle to large-scale production.

In 2011 the team achieved a new record of 7 percent efficiency for their “small molecule” BHJ cell, and according to Heeger, “We’re constantly discovering.”

WHAT’S NEXT?

Now that the basic chemistry and physics of organic solar cells have been worked out, the new frontier is ramping up efficiency and exploring innovative uses. Heeger is confident that better performance is within reach, saying “We will have a 15-20 percent [efficiency] technology.” Several companies are pursuing commercialization of this technology.

With organic PV’s unique properties, solar power can be used in completely new ways. For example, their transparency makes them much easier to integrate into buildings. “Putting them in windows is a great application,” says Heeger. Moreover, the ability to print them in an array of color could fully transform solar panels from eyesore to design element.

They could also be used on top of parking structures, letting in sunlight while charging by day and powering indoor lighting by night. And for those in sunny climes, think about this: Park your car on a hot summer day and an organic PV roof panel that runs a small air conditioner will keep the interior cool until you return.

In a short time, the greatest feat of organic solar could be a vanishing act. The technology will be so integrated into our cars, homes, and offices that even if it powers everything in sight, you may not see it at all.