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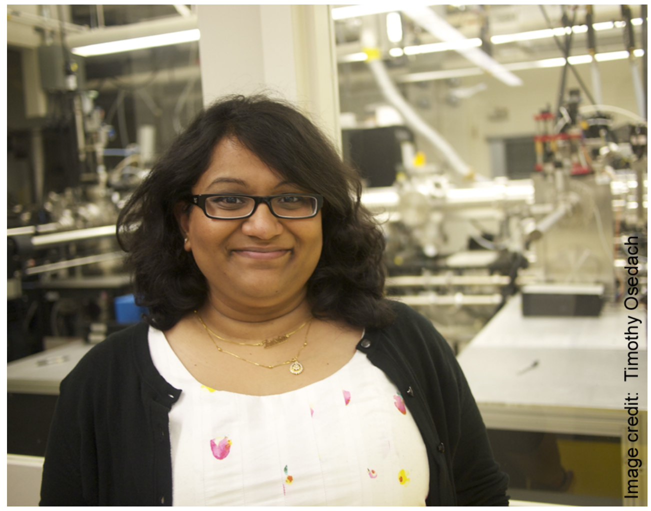
A Conversation with Trisha Andrew

Prachi Patel

The chemist and engineer talks about building lightweight solar cells on unconventional surfaces.



Trisha Andrew, a professor of chemistry at the University of Wisconsin, Madison, draws on her chemistry and engineering expertise to find ways to make low-cost and lightweight solar cells. Her specialty lies in depositing unconventional solar cell materials such as organic dyes and quantum dots on paper and fabrics. Prachi Patel spoke with the recently elected Packard Fellow about her work on this novel approach to photovoltaics.

Why make solar cells from organic dyes and nanomaterials?

The great advantage of using organic dyes or nanomaterials is their ability to accommodate any device architecture that you can dream of. Their efficiency is not high compared to traditional solar materials like silicon. But you can spin-coat them, spray-coat them, or vapor-deposit them onto any substrate you want.

We can make devices on flexible substrates like paper or textiles, which are completely unthinkable for traditional devices. Textiles are a particularly horrendous substrate for growing electronic devices because of their rough surfaces. However, with the nanomaterials that we use, we can use physical or chemical vapor deposition techniques that don't care about the surface of the substrate.

What are some key breakthroughs you've made in making these unconventional solar cells?

One advance I'm proud of is our use of commercial dyes. These dyes are mass produced by chemical companies to color plastics and other commodity materials. But we've found that these dyes are actually useful as the photoactive layers in solar cells. One of the pigments we use is the blue dye copper phthalocyanine.

Another big thing we do is to use chemical vapor deposition to deposit electrodes made of conductive polymers onto any substrate. Other people have tried this, but there are challenges in perfecting the chemistry. We're taking this beautiful organic chemistry for these polymers that's been developed before in solution, and we're simply translating it into the vapor phase. We're figuring out how to make them in a chamber under vacuum. That way, we can coat these polymers directly onto any rough substrate and get a coating that conforms to the surface.

What made you start building solar cells on textiles?

This project is a product of being approached by Marianne Fairbanks, professor in the School of Human Ecology at the University. She had a startup a few years ago that made solar-charging handbags. She basically stitched thin-film cadmium selenide solar cells onto the front of the bags. But it was hard to buy enough thin-film modules at a time to make enough bags to turn a profit. Second, it was kind of clunky.

When she read an article about my lab's paper solar cells, she wondered whether we could grow our technology directly on fabrics. Fabrics had never crossed my mind before then. But as soon as she suggested it, a light bulb went on.

We grow our devices on the nanoscale directly on the fabric, as if we were painting on top of it. So we preserve the mechanical properties of the fabric, like breathability, strength, or density.

For example, think about making a solar-collecting tent. Tent fabric has been fantastically engineered over the past

Published: October 16, 2015

50 years for mechanical stability and water resistance. If you stitch a solar cell onto that tent, you've put this brittle, clunky solar cell on a previously flexible, durable fabric. Instead, we could take any fabric made for aesthetic or functional purposes and simply add a coating that collects solar energy. That's powerful.

How far are these textile devices from practical applications?

My graduate student Lushuai Zhang has already grown a functional array of six solar cells on fabric. A power output of 1 W is our goal because that's what is needed to charge a cell phone. We also have a smaller milestone of 100 mW, which is the power needed to charge Fitbits and heart-rate monitors. Our current device leads to only a few microwatts of power, so we need to go up a couple orders of magnitude to reach our first goal. We've already shown a proof of concept, and we're going at a pretty fast pace, which is kind of exciting.

Prachi Patel is a freelance contributor to Chemical & Engineering News, the weekly newsmagazine of the American Chemical Society. Center Stage interviews are edited for length and clarity.

DOI: 10.1021/acscentsci.5b00322
ACS Cent. Sci. 2015, 1, 345−346