Momentum!

Fall 2015

Toward Creating a Better Future

Oregon State UNIVERSITY

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FRONT COVER
Kamesh Mullapudi prepares a flexible polyimide substrate for glucose sensor processing and fabrication.

BACK COVER
In 2012, OSU Engineers Without Borders worked with community members in Lela, Kenya, to build a well and rainwater catchment system that now supplies easily accessible drinking water for residents.

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Anti-reflective coating and printed solar cells

In addition to working on the display transistors, Chang is deeply involved in seeking solar energy solutions using additive manufacturing. He is director of the Oregon Process Innovation Center for Sustainable Solar Cell Manufacturing and founder of an Oregon State spin-off called CSD Nano. CSD Nano developed and patented the next generation of nanotech anti-reflective coatings for the solar industry.

The anti-reflective coating is made using nanoparticle inks that mimic the structure and antireflection properties of moth eyes. CSD Nano is in the market research phase, working with solar farms to determine the feasibility for commercializing the technology. A fair amount of international interest in this technology is evident.

Chang is also using additive manufacturing to print chalcopyrite (composed of copper, indium, gallium, and selenium) solar cells. The material is much more efficient than silicon, which is now used to manufacture solar panels.

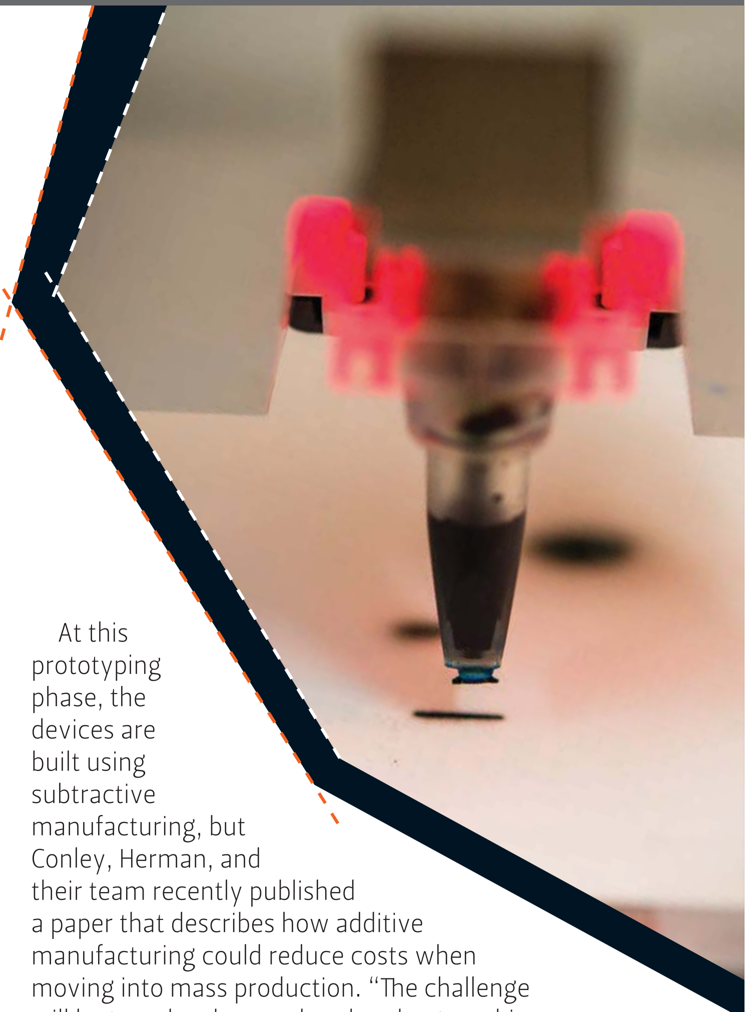
"Most of the solar cells are manufactured using a vacuum process to make the film that captures sunlight, but the process is slower and the cost is higher," said Chang.

Although commercialization is on the horizon, the team is not quite ready yet. "We're at about eight percent efficiency for the ink, so we need to improve the efficiency before we consider commercialization. We're looking for 12 to 15 percent efficiency," said Chang. Silicon-based solar cells operate at about 18 percent efficiency, but that difference could be balanced out by the lower cost of the chalcopyrite-based version.

Biosensors for continuous glucose monitoring

John Conley, professor in the School of Electrical Engineering and Computer Science and co-director of the Materials Synthesis and Characterization facility at Oregon State, has been working closely with Pacific Diabetes Technologies to build the biosensors for what will eventually become an artificial pancreas. The research team is working on the second generation of the device, which is more robust and reliable than the first generation.

"We've helped them improve the adhesion of the biosensors to the substrates," said Conley. The technology is undergoing animal testing at Oregon Health and Sciences University in Portland and on campus in Corvallis. "Basically, the idea is to combine continuous glucose monitoring with controlled injection of hormones, and their ultimate goal is to make an artificial pancreas, but they're doing it one step at a time."



At this prototyping phase, the devices are built using subtractive manufacturing, but Conley, Herman, and their team recently published a paper that describes how additive manufacturing could reduce costs when moving into mass production. "The challenge will be to redevelop an already robust working sensor, developed with the subtractive manufacturing, to get it to work with additive manufacturing — basically reworking the process to make sure the layers adhere properly to each other," said Conley.

He describes the vision, which involves roll-to-roll printing: "Imagine a newspaper printing process, but instead you would run the film of our flexible substrate through a big printer. It would print the sensors as the film zooms through."

The challenges in moving to additive manufacturing will be finding the right materials and chemistry. "There's a lot of chemistry involved in the ink formulation, and that's where the chemical engineers and the chemists get involved," said Conley. "The chemistry has to be such that it flows well — doesn't clog up or corrode the printer. It has to adhere well and make a dense film."

Conley observes that materials research for additive manufacturing is still in the early stages. Many materials must be stored or handled under tightly controlled temperatures and humidity conditions. "You want to be able to do this at room temperature in normal atmospheric conditions, as opposed to needing either a vacuum system or very high temperatures to deposit high-quality films, said Conley. "Right now, there are only a few materials that can be printed under room temperature conditions and still give the same quality as vacuum deposited films, so there's a lot of opportunity for materials researchers."