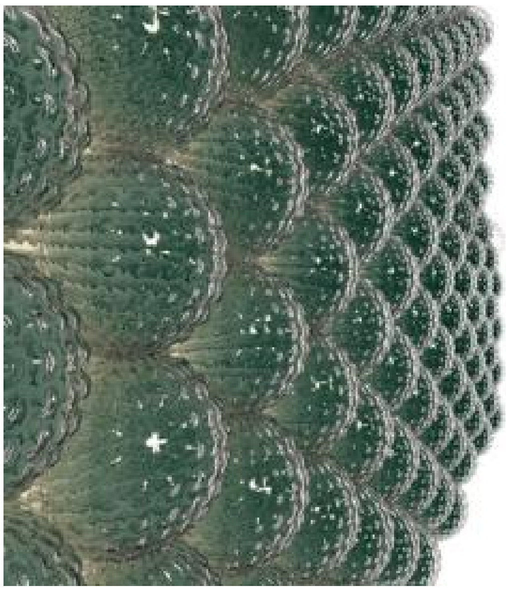
# Getting a charge out of solar 'paint'

February 14 2011, By Miles O'Brien and Marsha Walton



Energy generated from renewable sources has long promised to satisfy demands for more and cleaner electricity. Because renewable sources, such as sunlight and wind, can produce greatly fluctuating amounts of energy, they are most effectual when excess energy can be stored until it's needed. Credit: Prof. Gutierrez/Prof. Hermanovicz/Prof. Lee, University of California-Berkeley

Have you seen those big, bulky, breakable photovoltaic cells that now collect the sun's rays? Well, what if solar energy could be harnessed using tiny collectors that could be spray painted on a roof, a wall or even a window?

The science of converting sunlight into electrical energy is more than a century old, but the reality of doing it efficiently and affordably is ongoing.

"Not only does it involve fundamental science in terms of physics and chemistry, and in some cases biology, but there are major engineering challenges as well," notes Brian Korgel, a nanomaterials chemist at the University of Texas at Austin.

Korgel and his colleagues are a new breed of chemical engineers, looking for answers to the world's big problems.

"There was a time where the field of chemical engineering had a reputation of being really conservative. You'd get your degree in chemical engineering, and you'd work for a chemical plant with a hard hat or in a giant refinery," says Korgel.

That's no longer the only option.

"Chemical engineers are now able to take these new chemicals, like nanomaterials, and we're trying to create the technologies that can meet the global challenge of, say, energy sustainability. We're taking chemistry, we're inventing new ways to actually make materials that can't be made any other way," he continues.

With support from the National Science Foundation (NSF), that's what Korgel and his team are doing to create solar cells that are light, flexible, efficient and--often the biggest obstacle--affordable.

"It's challenging to get high efficiencies of conversion. For example, the basic single junction solar cell is fundamentally limited to an efficiency of 30 percent. So, if you made a perfect solar cell, the highest efficiency would be 30 percent," explains Korgel at his Austin lab.

Currently, manufacturing cells with anything near that level of efficiency requires high heat, a vacuum and is very expensive. Korgel's approach, using nanotechnology, is completely different.

"What we're doing right now in my research group is making nanocrystals. We're focused on 'CIGS'--copper, indium, gallium, selenide--and we make small particles of this inorganic material that we can disperse in a solvent, creating an ink or paint," he says.

This solar "paint" would have the same function as the large photovoltaic (PV) solar collectors on buildings and "solar farms" around the world.

Korgel describes the tiny collection devices as a "solar sandwich."

"So these devices are 'sandwiches,' where you have the metal contact on the bottom and metal contact on the top to extract the charge out; and the middle part is the part that absorbs out the light," explains Korgel.

This paint, made of the CIGS nanocrystals, can be sprayed on plastic, glass and even fabric to create a solar cell.

"So what we're able to do is create radically new ways of depositing inorganic films to make solar cells, and so we're trying to meet this challenge of much lower cost of manufacturing," he says.

One way to create these cells on a very large scale would be to print them on thin, flexible sheets, the same way huge presses now print newspapers. "And the final product would ideally look something like today's shingles," says Vahid Akhavan, one of Korgel's graduate research assistants. "You want to produce something that is very user friendly. So you could go to your local hardware store, buy them and install them on your roof."

These shingles would do double duty, generating electricity while serving as roofing material. They would be also stand up better in bad weather, such as hail and windstorms, than some of today's more fragile solar collectors.

A lot of challenges need to be conquered before solar energy becomes so commonplace. High on that list is improving the efficiency of these nanomaterial cells. "Right now, we have made devices that have an efficiency of 3 percent, and to be commercial, you really need to be at 10 percent," says Korgel. "But I think we can get to 10 percent. Those are just engineering challenges; they are not necessarily easy, but they are not fundamental roadblocks."

Depending on what part of the world is looking to transition to solar energy, that improved efficiency is critical.

"I did my post-doc in Dublin, Ireland, so I know cloudy days with five hours of sunlight," says Korgel. "So if you want to use solar, you need to have efficient devices that can harvest the sun under those conditions."

Another obstacle will be determining what raw materials can be used if this technology can be mass produced. The copper, indium, gallium, and selenide are not all cheap or readily available.

"Ultimately, thinking much further out, you want to go with a technology where you use elements that are earth-abundant," says Korgel.

One possibility is silicon, which is made from sand, abundant across our planet. But extracting the silicon from the sand is now an incredibly energy-intensive process and the chemicals it takes to do that are pretty harsh on the environment.

Korgel, his students and colleagues see all those problems as having answers. And he's also motivated by non-scientists eager to wean the world from diminishing fossil fuels.

"Everyone realizes this is a major problem, and so many people want to see it solved and are incredibly enthusiastic and supportive of the scientific and engineering community. And it's inspiring," says Korgel. "What it's given me is a deep appreciation of how important this problem of meeting energy sustainability is. It drives you further on to try and meet that need."

The Korgel lab is also investigating medical uses for nanomaterials. "These nanomaterials have unique properties. They might be fluorescent and give off light, they can be magnetically responsive. If you shine light on them, they can generate heat. So you can take all of these unique properties, and then they're so small that they can flow around in your bloodstream and get into organs," he says.

For example, a nano probe could detect a cancer cell and then deliver the medicine to kill it. "So, if you could come up with a nanoscopic unit that could detect a variety of different types of cancers or different diseases and then carry out a therapy of some sort, that would be a big deal," he says.

Provided by National Science Foundation