Research yields promising breakthrough in solar cells based on nanocarbon

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(Phys.org)—An exciting advance in solar cell technology developed at the University of Kansas has produced the world's most efficient photovoltaic cells made from nanocarbons, materials that have the potential to dramatically drop the costs of PV technology in the future.

"We actually broke the all-carbon PV efficiency record," said Shenqiang Ren, assistant professor of chemistry at KU, who spearheaded the research with colleagues from Massachusetts Institute of Technology. "Carbon nanotube-based solar cells, in the past, averaged less than 1 percent in efficiency. Even though these materials show such a large potential, there are so many problems. But we're addressing them. So now, our efficiency has risen to 1.3 percent. It doesn't get to the commercial level of efficiency, but we're still working on it, trying to optimize it, trying to get better efficiency out of it."

To be commercially viable, Ren said a photovoltaic panel must cross a 10 percent efficiency threshold—meaning it must covert a tenth of the sunlight input energy into solar cell output power. Today's commercially available silicone PV panels are 17 to 22 percent efficient, but they come with a very high price tag.

The KU researcher said that PV panels made from carbon nanomaterial could advance solar technology because they are made from cheap, easy-to-get and environmentally sustainable carbon materials, have high optical absorption and much better photostability—meaning their performance doesn't degrade after exposure to sunlight.

"In our research, we use carbon buckyballs, carbon nanotubes and a graphene derivative," said Ren. "The nanocarbon materials show remarkable photostablility without traditional packaging required in organic solar cells. We actually compared two types of solar cells in the laboratory. We had a standard organic solar cell, and then we made exactly the same all-carbon solar cell. Then, we compared the photodegradation without any protective packaging. The organic degraded so rapidly that after 100 hours the organic solar cell wasn't functional at all, but the all-carbon solar cell was functioning really well."

While the 1.3 percent efficiency rate of Ren's nanocarbon PV cells falls short of today's commercially available solar technology, the theoretical limit for all-carbon PV cells is 13 percent. If Ren and his colleagues can achieve in the real world what they theorize is possible using nanocarbon, the technology would thrive in the marketplace and could have a broader impact on technology beyond solar.

"Our target is to move forward this performance, and in the meantime we want to better understand the exciton dynamic and charge transfer," said Ren. "This carbon material is very new to photophysics, and a PV cell is just one of emerging applications from the all-carbon framework. It could open up a completely new carbon optoelectronics. For instance, we could use this carbon for photo detector or a sensor. Once we address these fundamental problems, there's a whole new field that can be opened up by this discovery."

Kansas NSF EPSCoR, Department of Energy, the Center for Environmentally Beneficial Catalysis and KU's New Faculty General Research Fund Program supported the Ren group's research at KU. Additionally, Ren credits KU's "Sustaining the Planet, Powering the World" initiative with bringing him to the university.

Ren's findings appear in the Oct. 9 issue of *ACS Nano*.

More information: pubs.acs.org/doi/abs/10.1021/nn302893p

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