Novel approach to perovskite solar cells – cheaper production and high efficiency

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The molecule, synthesised by the KTU chemists, assembles itself into a monolayer, which can cover a variety of surfaces and can function as a hole transporting material in a perovskite solar cell. Credit: KTU

A team of chemists from Kaunas University of Technology (KTU), Lithuania together with physicists from Helmholtz Zentrum Berlin (HZB) science institute, Germany, offers a novel approach for selective layer formation in perovskite solar cells. The molecule, synthesised by the KTU chemists, assembles itself into a monolayer, which can cover a variety of surfaces and can function as an economical hole-transporting material in a perovskite solar cell.

Perovskite-based solar cells are leading to new emerging photovoltaics, and already competitive with well-established solar technologies used in solar panels around the world. An important step toward mass production of this new generation solar cells is the development of efficient selective contact layers that would be compatible with the deposition of perovskite layers on various substrates.

Spin-coating and vapour deposition are the two main methods currently used for the formation of perovskite layers in solar cells. Spin-coating involves dripping liquid solution on spinning surfaces; during the process, a large amount of the material is lost. Vapour deposition requires high temperatures and complex vacuum technologies, and not all molecules are suitable for evaporating.

KTU chemists have synthesised a molecule that assembles itself into a monolayer, and which can evenly cover any oxide surface—including textured surfaces of the silicon solar cells used in tandem architectures.

Credit: KTU

"It's not polymer, but smaller molecules, and the monolayer formed from them is very thin. This, and the fact that the monolayer is being formed through dipping the surface into the solution makes this method much cheaper than the existing alternatives. Also, the synthesis of our compound is a much shorter process than that of the polymer usually used in production of perovskite solar cells," says Ernestas Kasparavi?ius, Ph.D. student at KTU

Faculty of Chemical Technology.

The synthesised material had to be tested. The team of physicists of HZB in Berlin, Germany headed by Dr. Steve Albrecht, in collaboration with KTU doctoral student Artiom Magomedov successfully used this new material as a hole transporting layer in perovskite solar cells.

"In our laboratory in Kaunas we studied use of the self-organising molecules to form the electrode layer as thin as 1-2 nm, evenly covering all the surface. During my internship in Berlin I was able to apply our material and to produce a first functioning solar element with just a monolayer-thick selective contact," says Magomedov, a researcher at KTU Faculty of Chemical Technology.

This self-assembling monolayer technique achieves extremely low material consumption and high efficiency—the element's power conversion efficiency was close to 18 percent, which is exceptionally high for a new technology. Also, when the self-assembling monolayer is used as a hole-transporting layer in perovskite cells, no additives are needed to improve performance. This might significantly improve the lifespan of the elements. Following initial success, scientists at KTU are synthesizing new materials for monolayer formation. The first tests of the optimized materials at HZB led to cells with over 21 percent efficiency.

More information: Artiom Magomedov et al, Hole Transporting Monolayers: Self-Assembled Hole Transporting Monolayer for Highly Efficient Perovskite Solar Cells (Adv. Energy Mater. 32/2018), *Advanced Energy Materials* (2018). DOI: 10.1002/aenm.201870139

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