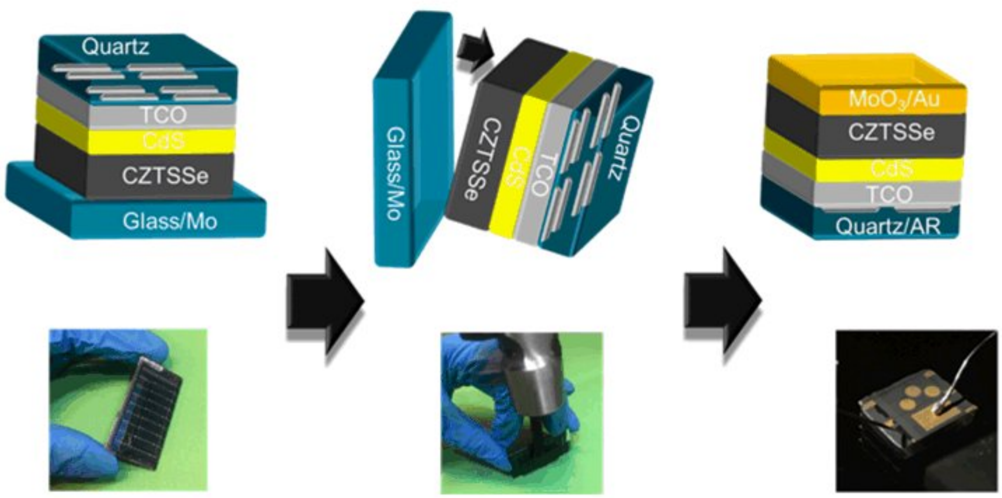
Breakthrough yields higher voltage and efficiency for a thin mineral-based solar cell

December 1 2017, by Laura Mgrdichian



Steps to engineer a new back contact for a kesterite-based solar device. First, an anti-reflective quartz coating is applied to the top of the device (the device will be illuminated through this layer). Next, the substrate and the device are physically separated, i.e. exfoliated, using a hammer. Finally, the new molybdenum/gold back contact is deposited. Credit: Richard Haight, IBM T.J. Watson Research Center.

(Tech Xplore)—The phrase "solar energy" often brings to mind large solar panels on the roofs of homes and businesses or huge arrays sprawled across sunny fields. But there is a need for low-light photovoltaics – materials that turn light energy into electricity – that can work indoors, providing power on a small, continuous scale.

Take, for example, the so-called Internet of Things, the network of appliances, electronics, cars, and other objects that contain sensors and tiny computers, all connected and exchanging information. Ideally, as these devices become more widespread and part of the background of daily living, they will be able to produce their own power from indoor lighting and sunlight. This will be achieved by thin, low cost, nontoxic, and efficient solar cells. Cells made of silicon, although the backbone of the industry, simply cannot be made thin enough for small-scale applications.

In a recent paper published in *Nature Energy*, researchers from the IBM T.J. Watson Research Center have made a key step in the development of solar cells based on the semiconductor kesterite, a naturally occurring, abundant mineral based on sulfide, a sulfur ion.

Kesterite is a member of a class of photovoltaics that is being intensely studied, but solar cells based on kesterite have been hindered by low "open-circuit" voltages (the maximum possible voltage across the cell) and mediocre efficiencies.

The group, led by IBM scientist Richard Haight, discovered a way to significantly improve the voltage of a kesterite solar cell. Their approach was based on a known issue with these cells, namely, that the back contact of the cell, which is formed during high-temperature processing, performs poorly, ultimately degrading the cell's overall performance. Haight and his team, as well as other research groups, have tried different ways of improving the back contact, but with limited success.

This time was different. Haight told *Tech Xplore*. "By replacing this contact with one deposited at room temperature and designed to optimize performance, we were able to achieve near-record power conversion efficiencies at substantially higher open-circuit voltages."

He and his group started by growing a kesterite layer on a glass substrate covered in molybdenum (Mo). Following a high-temperature anneal in additional sulfur and a slow cool, the kesterite absorber was incorporated into a fully functional solar cell that was then removed from the Mo-coated glass via a multi-step process called exfoliation and given a new back contact made of molybdenum oxide and gold. The resulting open-circuit voltage was significantly larger than that of cells with the previous back contact.

Additionally, the group successfully linked nine of their cells to form a solar device that would be able to run a low-power microprocessor, such as the type found in small electronics and appliances.

This approach to engineering the back contact may only be feasible for individual cells of perhaps up to a few square centimeters in size. Hence, suitable applications would be smaller, low-power devices that tend to run continuously and need to function in low-light conditions, where typical solar cells would fail. Nonetheless, Haight and his group do not rule out the possibility of finding ways to make kesterite-based cells appropriate for large-scale applications.

"Scaling to large substrates is a critical engineering challenge," he said. "Exfoliation could perhaps be achieved through a continuous peeling process using flexible substrates, but the difficult work of establishing such approaches would have to be done. We are considering some of these."

More information: Priscilla D. Antunez, et al, Efficient kesterite solar cells with high open-circuit voltage for applications in powering distributed devices, *Nature Energy* (2017). DOI: 10.1038/s41560-017-0028-5

Citation: Breakthrough yields higher voltage and efficiency for a thin mineral-based solar cell (2017, December 1) retrieved 25 April 2024 from https://techxplore.com/news/2017-12-breakthrough-yields-higher-voltage-efficiency.html