Tandem solar cell world record: New branch in the NREL chart

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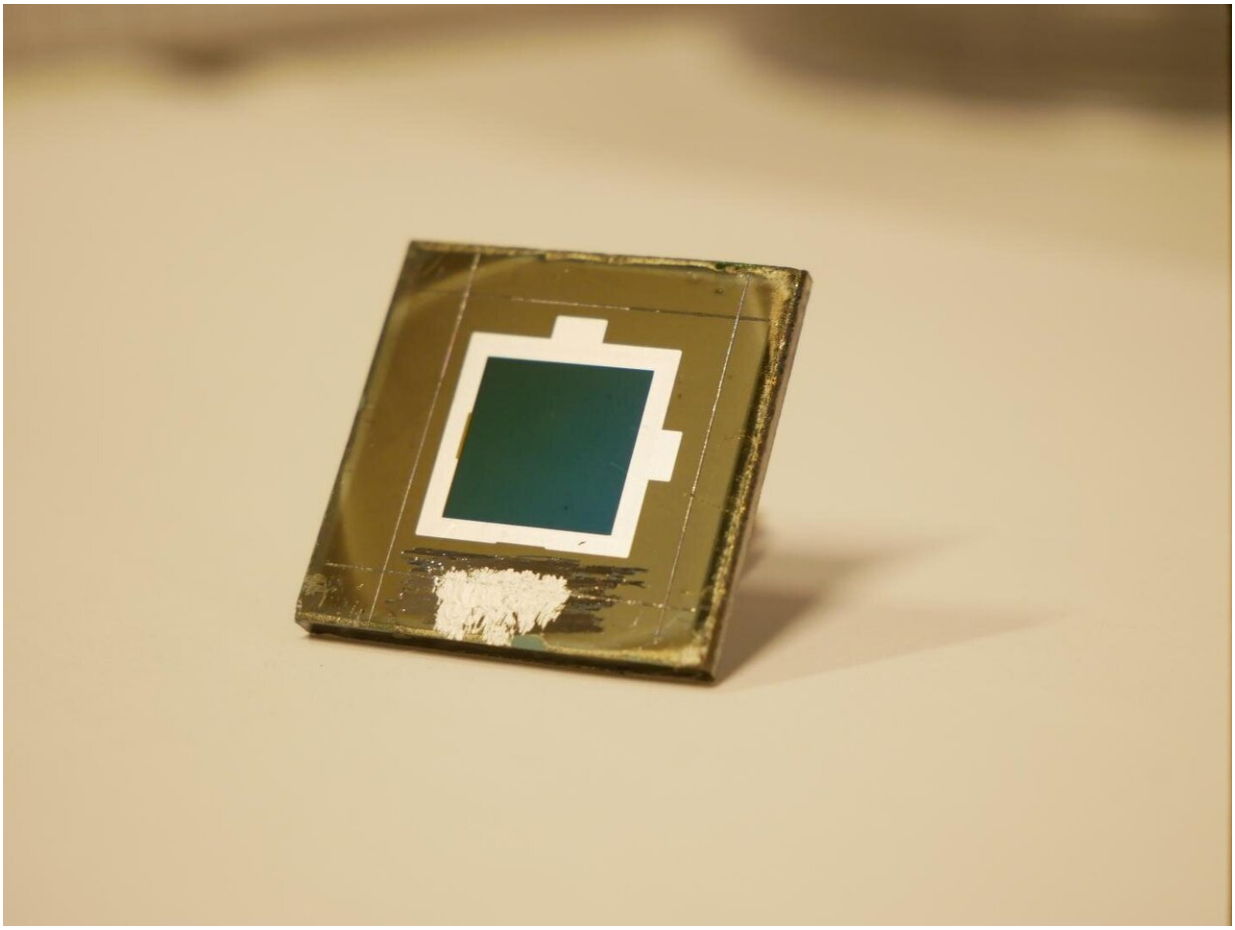

The CIGS-Pero tandem cell was realised in a typical lab size of 1 square centimeter. Credit: HZB

A new world-record-setting solar cell developed by HZB combines the semiconductors perovskite and CIGS to a monolithic 'two-terminal' tandem cell. Due to the thin-film technologies used, such tandem cells survive much longer in space and can even be produced on flexible films. The new tandem cell achieves a certified efficiency of 24.16 percent.

Tandem cells combine two semiconductors that convert different parts of the light spectrum into electrical energy. Metal-halide perovskite compounds mainly use the visible parts of the spectrum, while CIGS semiconductors convert infrared light. CIGS cells, which consist of copper, indium, gallium and selenium, can be deposited as thin films with a total thickness of only 3 to 4 micrometers; the perovskite layers are much thinner, at 0.5 micrometers. The new tandem solar cell made of CIGS and perovskite thus has a thickness of well below 5 micrometers, which would allow the production of flexible solar modules.

"This combination is also extremely lightweight and stable against irradiation, and could be suitable for applications in satellite technology in space," says Prof. Dr. Steve Albrecht, HZB. These results, obtained in a large collaboration, have been just published in the renowned journal *Joule*.

"This time, we have connected the bottom cell (CIGS) directly with the top cell (perovskite) so that the tandem cell has only two electrical contacts, so-called terminals," explains Dr. Christian Kaufmann from PVcomB at HZB, who developed the CIGS bottom cell with his team. "The introduction of rubidium has significantly improved the CIGS absorber material."

Albrecht and his team have deposited in the HySPRINT lab at HZB the perovskite layer directly on the rough CIGS layer. "We used a trick that

we had previously developed," explains former postdoc from Albrecht's group Dr. Marko Jošt, who is now a scientist at the University of Ljubjana, Slovenia. They applied so-called SAM molecules to the CIGS layer, which form a self-organized monomolecular layer, improving the contact between perovskite and CIGS.

The new perovskite CIGS tandem cell achieves an efficiency of 24.16 percent. This value has been officially certified by the CalLab of the Fraunhofer Institute for Solar Energy Systems (ISE).

Since such 'two terminal' tandem cells made of CIGS and perovskite now represent a separate category, the National Renewable Energy Lab NREL, U.S., has created a new branch on the famous NREL chart for this purpose. This chart shows the development of efficiencies for almost all solar cell types since 1976. Perovskite compounds have only been included since 2013—the efficiency of this material class has increased more steeply than any other material.

More information: Felix Lang et al, Proton Radiation Hardness of Perovskite Tandem Photovoltaics, *Joule* (2020). DOI: 10.1016/j.joule.2020.03.006

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