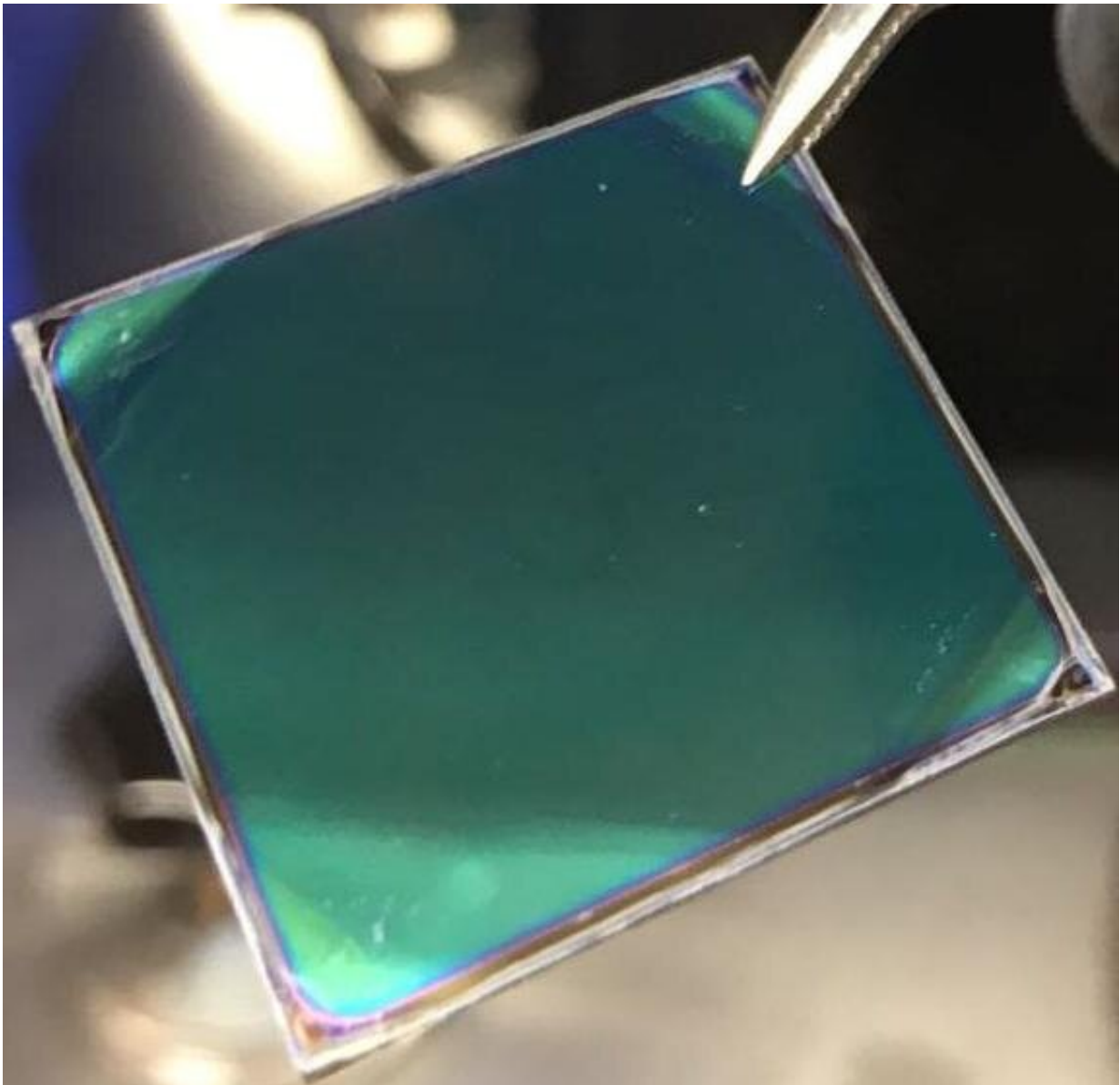


New fabrication method for perovskite solar cells promises to break the efficiency limit

December 11 2020, by Barry Fitzgerald



Credit: Junke Wang

The direct solar-to-electricity conversion enabled by solar cells can play a pivotal role in our future energy supply. Increasing the cost-effectiveness of solar cells is essential to accelerate the upcoming terawatt-scale solar industry. However, this is complicated as conventional crystalline silicon is already approaching its efficiency limit of 33 percent. One viable strategy is to fabricate solar cells that combine various light-absorbing materials that can capture a larger portion of sunlight, which could ultimately raise the efficiency to 68 percent. Ph.D. candidate Junke Wang has developed a new strategy to fabricate solar cells based on novel perovskite semiconductors that promise efficiencies above 35 percent. Wang successfully defended his thesis on December 10th.

Perovskite is an inorganic-organic hybrid compound that shows excellent properties for use in solar cell applications. Within a decade, [solar cells](#) based on a single perovskite [layer](#) have already reached efficiencies above 25 percent, which is on par with conventional inorganic solar technologies.

In comparison to [traditional materials](#), perovskite has many advantages such as being lightweight and low-cost. In addition, it can be made from solution mixtures or inks, like the ones to print newspapers. These inks can then be used to coat the surface of a substrate with a layer that is just hundreds of nanometers in thickness. As a result, this approach makes it easier to produce large-area solar panels from these solutions.

Interestingly, high-quality perovskite [materials](#) that absorb the different colors of sunlight can be obtained by changing the chemical composition of the perovskite film. Therefore, stacking various perovskite materials that can absorb different colors in one device, namely a perovskite

multijunction solar cell, offers an exciting route to break the efficiency limit at a low fabrication cost.

Processing challenges

Manufacturing such multijunction solar [cells](#) is a non-trivial task, given that the different material layers need to be deposited on top of each other while also being compatible with each other. Each perovskite material requires a certain film formation strategy to obtain [high performance](#), and this imposes tremendous processing challenges. Besides, as all perovskite layers are processed from solutions, the placement of one perovskite material on top of another can damage the underlying layer and lower the cell efficiencies.

A universal deposition strategy

In this research, Wang and colleagues in the Molecular Materials and Nanosystems group in the Department of Applied Physics demonstrated a simple, yet effective processing and integration method for three distinct perovskite layers.

This new method addresses major difficulties in manufacturing perovskite multijunction solar cells and is suitable for future large-scale production approaches. The researchers also designed and implemented a robust interconnecting layer capable of maintaining the integrity of all the perovskite layers during the deposition of one layer on top of another layer.

In a proof-of-concept solar cell, the combination of three different perovskite materials resulted in a 16.8 percent conversion efficiency. With further development of individual [perovskite](#) materials, the strategy developed during Wang's Ph.D. research can conceivably

increase the efficiency to above 35 percent. A component of the results from Wang's Ph.D. research have been published in a paper in the journal *Nature Communications*.

More information: Junke Wang et al. 16.8% Monolithic all-perovskite triple-junction solar cells via a universal two-step solution process, *Nature Communications* (2020). [DOI: 10.1038/s41467-020-19062-8](https://doi.org/10.1038/s41467-020-19062-8)

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