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Large, High-Quality Crystals Boost Perovskite Performance

Materials: Improvements in size and crystallinity bolster perovskite's charge transport properties

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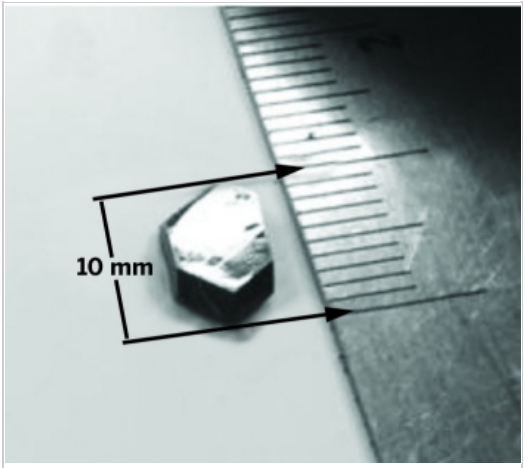

MONOLITHIC
Groups prepared millimeter-scale perovskite with promising charge transport properties.

Credit: *Science*

One way to make bigger and better perovskite solar cells could be making bigger and better perovskite crystals, according to three new studies.

Perovskite materials are inexpensive, easy to synthesize, and already competitive with benchmark semiconductors like crystalline silicon in terms of how efficiently they convert sunlight into electricity. Conventional perovskite cells use films of polycrystalline methylammonium lead iodide. Electrical charge carriers within typical microscopic crystals travel less than a micrometer on average before crashing into crystal defects or grain boundaries, which can restrict a device's performance.

Researchers have now grown high-quality millimeter-long crystals in which charge carriers can persist for dozens of micrometers without encountering an obstacle. And virtually any laboratory can produce the crystals using simple, inexpensive, solution-based techniques, the researchers say.

Two teams studied charge transport in large, single-crystal perovskite they were able to grow with very low defect densities (*Science* 2015, DOI: 10.1126/science.aaa2725 & 10.1126/science.aaa5760). The third team, led by Aditya D. Mohite and Hsing-Lin Wang of Los Alamos National Laboratory, created polycrystalline perovskite films with millimeter-sized grains. Solar cells based on the films achieved 18% power conversion efficiency (*Science* 2015, DOI: 10.1126/science.aaa0472).

That's shy of the record for perovskites, 20.1%, which is held by a solar cell that did not use large crystals, points out Joseph J. Berry, who coordinates perovskite research at the National Renewable Energy Laboratory, in Colorado. "A solar cell is more than just the best materials," says Berry, who was not involved in the new studies. "This is a very compelling advance, but it will take some more work to squeeze out all the performance."

The new high-quality crystals may enable a better understanding of perovskites' fundamental material properties, which have been obscured by defects, says Osman M. Bakr of King Abdullah University of Science & Technology, in Saudi Arabia, who led one of the single-crystal studies.

The crystals could be useful in other devices, such as light-emitting diodes, lasers, and even radiation detectors, as demonstrated in the third report by Jinsong Huang of the University of Nebraska, Lincoln, and coworkers. Berry also tells C&EN that he's spoken with the Los Alamos team about using its crystals for a project that's unrelated to photovoltaics.

"What we have is a fantastic material," says Mohite, one of the Los Alamos team's leaders. "I think everyone will be tempted to work with it."

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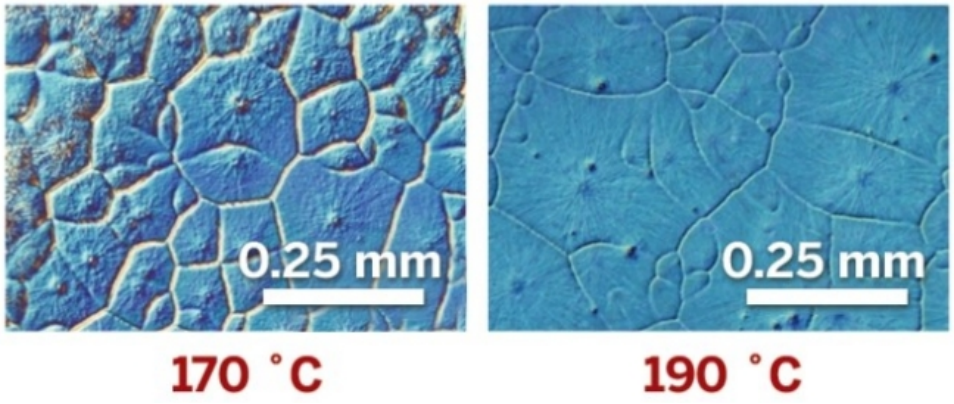

HEATING UP
Researchers could control a perovskite's grain size by tuning growth temperature. Polycrystalline films with large grains have high efficiencies, which researchers believe they can further improve.

Credit: *Science*

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