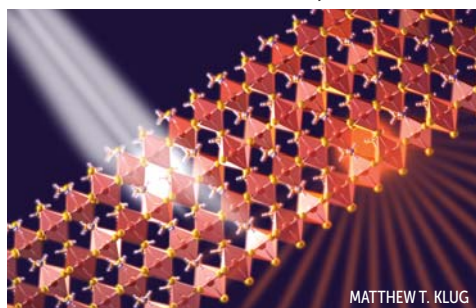


HEALING DEFECTS IN PEROVSKITE FILMS

Since their debut in photovoltaic cells in 2009, organometallic halide perovskites have emerged as one of the most rapidly advancing photovoltaic technologies in history. Perovskite solar cells today exhibit a power-conversion efficiency of 22%, on par with that of commercial silicon-wafer cells. Perovskites can be printed as flexible polycrystalline thin films by solution processing, one of the least expensive methods available (see *PHYSICS TODAY*, May 2014, page 13). But the polycrystalline films contain a lot of atomic vacancies, interstitials, and other defects that trap photoinduced charge carriers and reduce the flow of current. To passivate those defects—that is, to tie up the dangling bonds that create trap states—a collaboration led by MIT and Cambridge University researcher Samuel Stranks has developed a treatment that could hardly be simpler: a half-hour exposure to white light in humid air.

When applied to thin films of the solution-processed methylammonium lead iodide, the treatment increased the films' internal photoluminescence quantum efficiency—a measure of how efficiently a material reemits light from every absorbed photon—from 1% to 89%. As more defect states become passivated, more photoinduced electrons and holes are free to recombine in transitions across the gap between the valence and conduction bands—emitting light as they do so. The lower the films' defect density is, the higher the luminescence and solar cell performance.

As charge carriers in the perovskite are generated by incident light, they react with air to create O_2^- ions. Those ions, in turn, react with the material's methylammonium cations and degrade the film



into lead iodide and other debris products. But if the air exposure is temporary and the reactions halted, the researchers propose, the degradation doesn't run amok and the superoxide ions passivate iodine vacancies. The role of moisture is murkier,

but the researchers hypothesize that humid air reduces the defect density to an even greater extent by forming a nanometer-thin amorphous shell of degradation products that further passivates the surface and hinders the degassing of the O_2^- species from the perovskite. When the films were irradiated in the presence of light and dry air, the observed rise in luminescence efficiency lasted for hours. When the air was humid, it persisted for weeks. A key question is how to make the improvement last for years. (R. Brenes et al., *Joule* **1**, 155, 2017.)

—RMW **PT**

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