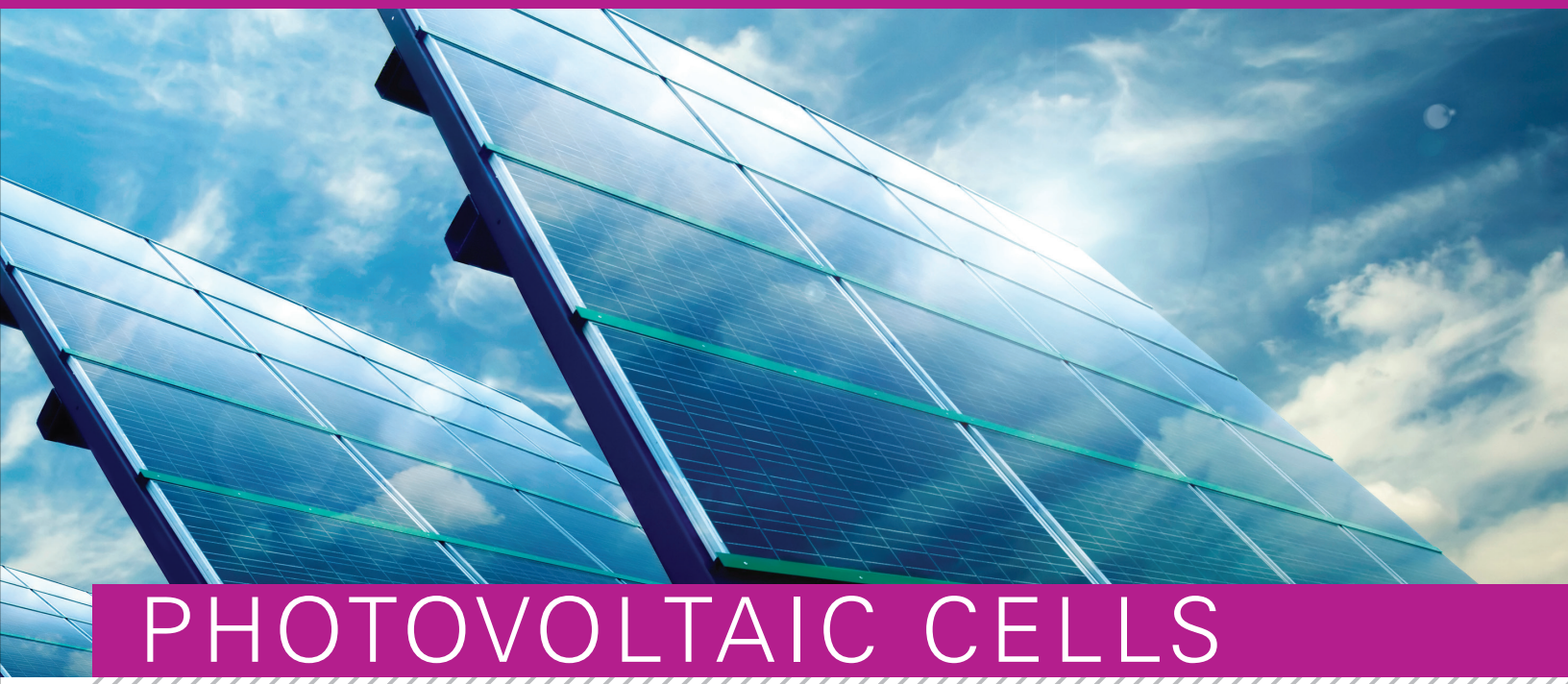

PHOTOVOLTAIC CELLS

Yan researching sustainable methods of clean solar electricity generation

With more than 120 terawatts of solar power irradiating the earth, photovoltaics offers the promise of essentially limitless energy for powering society. The reality, though, depends on whether the cost of the technology can be made competitive with more traditional carbon-based sources.

To that end, Yanfa Yan, a faculty member at the Wright Center for Photovoltaic Innovation and Commercialization and an Ohio research scholar endowed chair at the University of Toledo, is researching sustainable methods for clean solar electricity. In particular, he's combining two independent research focuses: efficiencies of solar cells and solid-state lighting devices, based on epitaxial single-crystal thin films; and efficiencies and cost reduction, based on polycrystalline thin films, by specifically investigating the theoretical properties of lead-halide-based perovskites.

Perovskites are a broad class of crystalline minerals that only in the past five years have been used to convert solar energy to electricity. Since then, the efficiency of perovskite solar cells has climbed from 3.8 percent to 19.3 percent, a pace of improvement unmatched by any other solar technology.

"To improve the cost metric, it is crucial to both dramatically reduce solar module fabrication cases, as well as improve device efficiencies. Lead-halide-based perovskites have burst onto the scene with a relatively quick demonstration of efficiencies, and simple low-temperature, low-cost processing," Yan said. "Despite these attractive features, some limitations need to be addressed before this approach is suitable for commercialization."

Specifically, the device efficiency at the cell level needs to be improved to more than 20 percent in order for the promise of an ultra-low-cost technology to be realized, the toxic heavy metal lead needs to be replaced with a less toxic alternative, and the stability of the materials and devices towards moisture, air and temperature needs to be established and improved.

Yan and his team are leveraging the computing resources at the Ohio Supercomputer Center to evaluate the structural stability of proposed non-lead perovskite photovoltaic absorbers, as well as their electronic and optical properties. They'll also, through theoretical models, calculate the defect physics in wide-bandgap perovskites, and examine the structure and effects of extended defects, such as dislocations and grain boundaries in photovoltaic materials.

"Our goal is to develop unique semiconductors that can be made into polycrystalline thin films that are electronically as good as single-crystal thin films," Yan said. "This is a new grand challenge of our time."

Above: Yan is investigating methods for developing highly efficient yet low-cost solar cells based on polycrystalline thin films, by specifically investigating the theoretical properties of halide-based perovskites.

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