



Energy Quarterly

News and analysis on materials solutions to energy challenges www.mrs.org/energy-quarterly

Inside:

EDITORIAL

Perovskites-To be continued

INTERVIEW

Perovskite photovoltaics: David Mitzi addresses the promises and challenges

ENERGY SECTOR ANALYSIS

Perovskites: Is there a reason for concern?

ENERGY QUARTERLY ORGANIZERS

CHAIR M. Stanley Whittingham, State University of New York at Binghamton, USA Anshu Bharadwaj, Center for Study of Science, Technology and Policy, India David Cahen, Weizmann Institute, Israel Russell R. Chianelli, The University of Texas at El Paso, USA George Crabtree, Argonne National Laboratory, USA Sabrina Sartori, University of Oslo, Norway

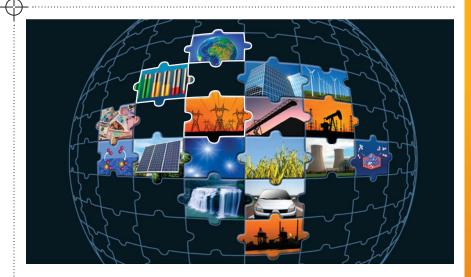
Anke Weidenkaff, University of Stuttgart, Germany

Steve M. Yalisove, University of Michigan, USA

Images incorporated to create the energy puzzle concept used under license from Shutterstock.com Energy Sector title image: Researchers at the University of Oxford have made metal halide perovskite solar cells that contain tin as the metal instead of toxic lead. Credit: The University of Oxford.

To suggest ideas for Energy Quarterly. to get involved, or for information on sponsorship, send email to materialsforenergy@mrs.org.





Perovskites—To be continued

The versatile perovskite structure ABX₃ offers an extensive playing field for solidstate chemists, physicists, and materials scientists since it is exceptionally stable so that most elements of the periodic table can be placed on the A-, B- and X-sites. These compositional variations lead to a multitude of useful properties, from superconductivity to resistance switching, thermoelectric, piezoelectric, and catalytic activity, to name a few. Therefore, it is also commonly called the chemical chameleon (A. Reller, T.B. Williams, *Chemistry in Britain* **25**, 1227 [1989]). Until recently, most of these interesting functions were found in oxide-type perovskites. Thus, it came as a surprise when hybrid lead halogenide perovskites turned out as "the" perovskite materials due to their extraordinary photovoltaic properties that found expression in countless scientific publications worldwide. The soft hybrid material methylammonium lead iodide (MAPI), which was discovered by Dieter Weber in 1978 (D. Weber, Zeitschrift für Naturforschung B 33, 1443 [1978]), became even more famous than the hard oxidebased counterparts. But these materials are completely different from the perovskitetype materials we are using in various applications such as batteries and computers since they are, in contrast, chemically, biologically (due to the methylammonium cation), and thermally rather unstable and decompose in air and moisture. So the huge advantage of the perovskite structure, which allows us to use them in catalytic and other redox reactions or in high-T applications, suddenly vanishes. Nevertheless, this instability problem (which is a disadvantage for their technical application today) might be solved as well as the impurity issue, which was formerly the major objective raised against oxide semiconductors in the first place.

The hybrid perovskite can also be viewed as a derivative of Pb iodide (known as very good ionic conductors), where the conductor is embedded in methylammonium organic matter, leading to interesting PV properties. Even in this system, the strong perovskite structure is holding organic and inorganic parts of the material together.

Therefore, chances are that the oldest and most abundant structure type (remember that the perovskite-type CaSiO₃ is building the earth mantle) might bring even more unforeseen surprises in the future.

Anke Weidenkaff