

## AKE 2: Renewable Energy: Photovoltaics

Zeit: Montag 11:00–12:15

Raum: S Aula

**Hauptvortrag**

AKE 2.1 Mo 11:00 S Aula

**Roadmap and roadblocks for multi-junction device technology based on metal halide perovskites** — ●EVA UNGER — Department of Chemistry, Lund University, Lund, Sweden — Helmholtz Center Berlin for Materials and Energy, Berlin, Germany

Solar cells based on metal-halide perovskite semiconductors inspire high hopes for efficient low-cost solar cell technology. These materials are promising to realize efficient tandem solar cell technology compatible with conventional solar cell technology based on silicon. Multi-junction solar cell devices with efficiencies exceeding 30% could be achieved by boosting silicon solar panels with a device based on absorber materials with optical band gaps of about 1.7 eV. In this respect, the ease of tuning the optical properties of metal halide perovskite materials and the possibility to achieve highly efficient devices entirely by solution-based deposition methods make this class of evolving semiconductors an ideal case to develop low-cost and scalable multi-junction device technology. This talk will give an overview over the state of the art and current performance metrics of metal-halide perovskite device technology. Close to the ideal band gap for absorbers for tandem solar cell stacks of 1.7 eV, the onset of photo-induced halide migration becomes limiting to the open circuit voltage indicating an intriguing but potentially hampering intrinsic properties of metal halide perovskites to their application in solar energy conversion devices.

AKE 2.2 Mo 11:30 S Aula

**Highly Stable and Efficient Perovskite Solar Cells Via Multication Engineering** — ●MICHAEL SALIBA, ANDERS HAGELDT, and MICHAEL GRAETZEL — EPFL, Lausanne, Switzerland

Perovskites have emerged as low-cost, high efficiency photovoltaics with certified efficiencies of 22.1%. The perovskites used for solar cells have an ABX<sub>3</sub> structure where the cation A is methylammonium (MA), formamidinium (FA), or Cs; the metal B is Pb; and the halide X is Br or I. Unfortunately, single-cation perovskites often suffer from phase, temperature or humidity instabilities. This is particularly noteworthy for CsPbX<sub>3</sub> and FAPbX<sub>3</sub> showing a photoinactive yellow phase at room temperature instead of the more desired photoactive black phase.

Here, we investigate triple cation (with Cs, MA, FA) perovskites resulting in significantly improved reproducibility and stability. We then use multiple cation engineering as a strategy to integrate the seemingly too small Rb (that never shows a black phase as a single-cation perovskite) to study novel multication perovskites.

One composition containing Rb, Cs, MA and FA resulted in a stabilized efficiency of 21.6%. The open-circuit voltage of 1.24 volts at a band gap of 1.63 eV leads to a very small loss-in-potential of 0.39 V, versus 0.4 V for commercial silicon cells. Polymer-coated cells maintained 95% of their initial performance at 85°C for 500 hours under full solar illumination and maximum power point tracking.<sup>(1)</sup>

(1) Saliba et al., Incorporation of rubidium cations into perovskite solar cells improves photovoltaic performance. Science (2016).

AKE 2.3 Mo 11:45 S Aula

**Growth-control of the ordered double-perovskite structure in (Pr<sub>0.5</sub>Ba<sub>0.5</sub>)CoO<sub>3-δ</sub> thin films** — ●GUNKEL FELIX<sup>1</sup>, HAUSNER CLEMENS<sup>2</sup>, DAVID N. MÜLLER<sup>2</sup>, DANIEL BICK<sup>1</sup>, LEI JIN<sup>3</sup>, CHUNLIN JIA<sup>3</sup>, THEO SCHNELLER<sup>1</sup>, ILIA VALOV<sup>2</sup>, and DITTMANN REGINA<sup>2</sup> — <sup>1</sup>Institute of Electronic Materials (IWE2), RWTH Aachen University — <sup>2</sup>Peter Grünberg Institut, Forschungszentrum Jülich GmbH — <sup>3</sup>Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons, Jülich

The complex oxide compound (Pr<sub>0.5</sub>Ba<sub>0.5</sub>)CoO<sub>3-δ</sub> (PBCO) is considered an efficient catalytic oxide for oxygen evolution half-reaction (OER) taking place during water splitting operation. We discuss structural and electrical properties of epitaxial PBCO thin films serving as model systems for exploring the atomistic processes during OER. PBCO thin films are synthesized in a disordered and in an ordered double-perovskite crystal structure by controlling the growth temperature during pulsed laser deposition. The thin films are fabricated with defined surface morphologies and crystal orientation. During the growth process, the transition from disordered to ordered phase can be monitored directly by means of electron diffraction (RHEED). The epitaxial thin films show catalytic activity comparable to their porous counterparts fabricated by chemical routes, making them ideal model templates for systematic studies. The ability to control the ordered double-perovskite phase of PBCO bears the potential to force the formation of structural oxygen vacancies within the lattice with atomic precision and to tailor active sites for OER on the nanoscale.

AKE 2.4 Mo 12:00 S Aula

**Influence of the pH value of the dye on the electrical properties of dye sensitized solar cells prepared with anthocyanins** — ●IRÉN JUHÁSZ JUNGER<sup>1</sup>, SARAH VANESSA HOMBURG<sup>1</sup>, HUBERT MEISSNER<sup>1</sup>, THOMAS GRETHE<sup>2</sup>, ANNE SCHWARZ-PFEIFFER<sup>2</sup>, JOHANNES FIEDLER<sup>1</sup>, ANDREAS HERMANN<sup>1</sup>, TOMASZ BLACHOWICZ<sup>3</sup>, and ANDREA EHRLMANN<sup>1</sup> — <sup>1</sup>Bielefeld University of Applied Sciences, Faculty of Engineering and Mathematics, Bielefeld (Germany) — <sup>2</sup>Niederrhein University of Applied Sciences, Research Institute for Textile and Clothing (FTB), Mönchengladbach (Germany) — <sup>3</sup>Silesian University of Technology, Institute of Physics - Center for Science and Education, Gliwice (Poland)

In recent years the harvesting of renewable energies became of great importance. This led to a rapid development of dye-sensitized solar cells which can be produced from cheap, low-purity materials. The best electrical properties are provided by cells prepared using synthetic, ruthenium based dyes. Unfortunately, most of them are toxic and expensive. The anthocyanins extracted for example from hibiscus flowers yield a cheap and eco-friendly alternative to the toxic dyes, however, with a loss of solar cell efficiency. Our aim is to improve the conversion efficiency and the stability of solar cells prepared with anthocyanins by changing the pH value of the dye. In order to find the optimal pH value, its influence on the solar cell properties is investigated.