DS 16: Thin Film Applications 2

Time: Wednesday 11:00–12:00 Location: H14

DS 16.1 Wed 11:00 H14

High Open-Circuit Voltage $Cs_2AgBiBr_6$ Carbon-Based Perovskite Solar Cells Via Green Processing of Ultrasonic Spray-Coated Carbon Electrodes from Waste Tire Sources — •Fabian Schmitz and Teresa Gatti — Center for Materials Research, Justus Liebig University, Giessen, Germany

Although top-notch lead-based perovskite solar cells (PSCs) achieve power conversion efficiencies >25%, they are still hindered from commercial implementation by their low environmental stability, high toxicity and optimizable costs. The latter could be reduced by eliminating the metal back electrode as well as the hole-transport material by substituting both with a conductive carbon material to create carbon-based PSCs (C-PSCs). Furthermore, the utilization of perovskite materials based on other metallic compounds could tackle the other two issues of stability and toxicity. A promising example that combines both high environmental stability and low toxicity is the double perovskite $Cs_2AgBiBr_6$.

In our work, we present the deposition of "green" carbon electrodes onto $Cs_2AgBiBr_6$ thin films via high-throughput ultrasonic spray coating to prepare lead-free C-PSCs. For our sustainable approach, we started from a carbon material obtained from the hydrothermal recycling of waste tires and dispersed it in isopropanol. This additive-free ink worked as a precursor for the upscalable ultrasonic spray deposition method to fabricate carbon electrodes under ambient atmosphere and at a low substrate temperature. Through this procedure we obtained C-PSCs with record open-circuit voltages of >1.2 V.

DS 16.2 Wed 11:15 H14

Indirect band gap semiconductors for thin-film photovoltaics: High-throughput calculation of phonon-assisted absorption — •Jiban Kangsabanik, Mark Kamper Svendsen, Alireza Taghizadeh, and Kristian S. Thygesen — Technical University of Denmark, Denmark

Photovoltaics is one of the most promising ways towards meeting the ever-increasing global energy demand in a sustainable and eco-friendly way. Thin-film materials (GaAs, CdTe, InP, CIGS, $MAPbI_3$, etc) are rapidly growing in terms of market share in recent times, showing comparable efficiencies to the current Si-based technology. Currently, these well-known thin-film materials possess some major drawbacks associated with low material abundance (In, Ga), toxicity (Cd, As, Pb), and long-term device stability (perovskites). As such, finding new materials with desirable physical attributes remains one of the key aspects in this area. Indirect bandgap semiconductors, which occupy a major portion of the semiconductor space are mostly ignored in recent material screening studies. Here, we propose a recipe to evaluate PV efficiency for indirect gap materials via calculating phonon-assisted absorption, which is high-throughput friendly. Using this recipe, we evaluate chemically stable unary and binary materials from the Open Quantum Materials Database for PV application. From our final screening, we identify well-known binary thin film materials (GaAs, CdTe, and InP) as well as a number of the emerging PV materials (PbS, SnS, Se, GeSe, etc). Additionally, we find a number of indirect gap materials with potential for thin-film PV device application.

DS 16.3 Wed 11:30 H14

Physical unclonable function based on unsorted carbon nanotube random networks in multi-contact field-effect transistors — Jonas Schroeder[1], •James W. Borchert[1], Patrick Schuster[2], Peter Eder[2], Stefan Heiserer[3], Josef Biba[3], Georg S. Duesberg[3], Ulrich Rührmair[2,4], and R. Thomas Weitz[1] — [1]Georg-August Universität Göttingen, Göttingen, Germany — [2]Ludwig-Maximilians-Universität München, München, Germany — [3]Universität der Bundeswehr München, Neubiberg, Germany — [4]University of Connecticut, Storrs CT 06269, USA

The standard practice in cryptography of using digital binary keys that are permanently stored on devices is prohibitively inefficient for some applications and open to both physical and software-based attacks. A promising alternative approach known as 'physical unclonable function' (PUF) instead uses the inherent random variation in fabrication to create physical 'keys' that produce unique randomized responses to defined challenges. Electrical PUF devices based on random networks of unsorted carbon nanotubes (CNTs) have shown promise, but so far have been limited in terms of scaling up the number of challenge-response pairs (CRPs) that can be extracted. Here, we demonstrate how gating the CNT networks might be a useful method for expanding the number of CRPs, thus strengthening the scalability of the PUF. We show CNT networks implemented in modified field-effect transistors with up to 12 contacts. The output randomness and stability of the devices are investigated, and further routes for improvement are discussed.

DS 16.4 Wed 11:45 H14

Redox-based Memristive Devices for Neuromorphic Systems — •Benjamin Spetzler, Seongae Park, Anna Linkenheil, Tzvetan Ivanov, and Martin Ziegler — Technical University Ilmenau, Ilmenau, Germany

Redox-based memristive devices have demonstrated promising properties for their application as synaptic elements in neuromorphic computing systems. The device characteristics are the product of a variety of complex mechanisms, and electronic and ionic processes need to be precisely tuned, which requires a deep understanding of the underlying physical mechanisms and control of the fabrication parameters. We present redox-based memristive elements and show how their properties can be tailored by systematic design variations for applications in neuromorphic computing architectures. In this context, the influence of different oxide layer systems and electrode materials on the device characteristics is analyzed to assess their properties for neuromorphic computing. The experimental findings are supported by a numerical device model, which connects the physical processes with technology parameters, and permits a deeper understanding of the origin of the current-voltage hysteresis. Furthermore, we discuss the system integration of memristive devices and present memristive device arrays.

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