DS 12: Focused Session: Inhomogeneous Materials for Solar Cells II

Although multinary compound semiconductors exhibit a variety of inhomogeneities - such as strong local concentration fluctuations, built-in vertical concentration gradients, rough interfaces, and a high density of grain boundaries - they are among the leading solar cell technologies. In this focused session, the impact of inhomogeneities on the carrier transport in solar cells shall be addressed with emphasis on material growth, characterization, and modeling. Therefore, state-of-the-art research and challenges will be highlighted for a broad range of related materials such as chalcopyrites, kesterites, perovskites, and group III-nitrides.

Organizers: Roland Scheer (MLU Halle Wittenberg), Frank Bertram (OvGU Magdeburg), and Jürgen Christen (OvGU Magdeburg)

Time: Monday 15:00–16:15 Location: CHE 89

Topical Talk DS 12.1 Mon 15:00 CHE 89

Defects in Chalcopyrites — •Susanne Siebentritt — Laboratory for Photovoltaics, Physics and Materials Science Research Unit, University of Luxembourg

Chalcopyrites (Cu(InGa)Se2) are used as absorbers in thin film solar cells. Their off-stoichiometry and their polycrystalline structure pose challenges for their semiconductor physical analysis.

The talk will present recent progress in the analysis of recombination centres and their effect on photogenerated carriers by spectral photoluminescence (PL) measurements. On the one hand side they provide information about quasi-Fermi level splitting, which indicates the amount of recombination. On the other they allow to investigate the energy positions of deep defects, which act as recombination centres. PL will be compared to results from admittance spectroscopy (AS), which can also indicate deep defects. In AS, however, it is difficult to distinguish between deep defects, barriers and other interface effects. The comparison between PL and AS indicates that the main steps are rather due to barriers than to deep defects.

Invited Talk DS 12.2 Mon 15:30 CHE 89

Growth of InGaN film and monolayer by molecular beam epitaxy — •Xinqiang Wang[1], Zhaoyin Chen[1], Xiantong Zheng[1], Xin Rong[1], Bowen Sheng[1], Bo Shen[1], Tobias Schulz[2], Martin Albrecht[2], Frank Bertram[3], and Jürgen Chirsten[3] — [1]State Key Laboratory of Artificial Microstructure and Mesoscopic Physics, School of Physics, Peking University, Beijing, 100871, China — [2]Leibniz-Institute for Crystal Growth, Berlin, Germany — [3]Institute of Experimental Physics, Otto-von-Guericke-University Magdeburg, 39106 Magdeburg, Germany

InGaN, which nearly perfectly matches the solar spectrum, is a good candidate for high efficiency solar cell. However, high quality InGaN, in particular with high In content, is difficult to realize. To solve this problem, Yoshikawa et al proposed to use (InN)m/(GaN)n digital alloys instead of random InGaN alloys making the InGaN in long range ordering. This approach attracted great interest due to its potential application in devices such as solar cells. Unfortunately, the growth is difficult as well since it needs the atomical level control at either InN or GaN layer. In this talk, we will first report our effort on fabricating solar cells by using InGaN/GaN multiple quantum wells, where a positive photovoltaic efficiency temperature coefficient up to 423K have bee observed. Then, we focus on growth of InGaN films with different In compositions. An InGaN layer with In composition changed from 0-100% on the same wafer have been grown as well. Finally, we will first report manipulation of In(Ga)N monolayer by molecular beam epitaxy.

DS 12.3 Mon 16:00 CHE 89

Investigation of Carrier Transport in CuInGaSe2 by Highly Spatially, Spectrally, and Time Resolved Cathodoluminescence Microscopy — •Mathias Müller[1], Martin Müller[1], Torsten Hölscher[2], Setareh Zahedi-Azad[2], Matthias Maiberg[2], Frank Bertram[1], Roland Scheer[2], and Jürgen Christen[1] — [1]Institute of Experimental Physics, Otto-von-Guericke-University Magdeburg, Germany — [2]FG Photovoltaik, Martin-Luther-University Halle-Wittenberg, Germany

To gain a deeper understanding regarding transport of carriers and the influence of inhomegeneities, highly spatially, spectrally, and time resolved cathodoluminescence (CL) measurements have been performed on polycrystalline CuInGaSe2 (CIGSe). Absorbers with varying Cu/III-ratios (CGI: 0.73 and 0.86) and therefore varying grades of disorder were investigated.

For this purpose two separate experiments were combined. Carrier diffusion length was derived temperature dependent from spatially resolved CL measurements as was the initial carrier lifetime from time resolved CL experiments.

With decreasing temperature from 300 K to 4.5 K the diffusion length increases from 6 μm to 27 μm (CGI 0.86) and 23 μm (CGI 0.73). Simultaneously, carrier lifetime increases from 20 ns (@ 125 K) to 48 ns (@ 4.5 K) and from 3 ns (@ 125 K) to 37 ns (@ 4.5 K), respectively. The resulting mobilities follow a power law with $\mu \propto T^{-0.86}$ (CGI 0.86) and $\mu \propto T^{-0.43}$ (CGI 0.73), which reveals scattering at neutral defects as the dominant mechanism, reaching up to 340,000 cm^2/Vs at 4.5 K.