HL 24: Joint Focussed Session: Thin Film Chalcogenide Photovoltaics III

Time: Monday 16:00–17:30 Location: GER 37

HL 24.1 Mon 16:00 GER 37

Time dependent capacitance voltage measurements on Cu(In,Ga)Se_2 Solar Cells — •Tobias Adler[1], Wolfram Witte[2], Dimitrios Hariskos[2], and Andreas Klein[1] — [1]Darmstadt University of Technology, Institute of Materials Science, Petersenstrasse 32, D-64287 Darmstadt, Germany — [2]Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW), Industriestrasse 6, D-70565 Stuttgart, Germany

Capacitance Voltage (C-V) measurements are widely used to determine the doping density of semiconductor interfaces in dependence on the width of the space charge layer. In Cu(In,Ga)Se_2 (CIGS) solar cells we observe a time dependent capacitance signal, which can be explained by different models like filling and emptying of electronic (metastable) defect states or by the diffusion of copper ions. The observed capacitance transients are compared to the different models.

HL 24.2 Mon 16:15 GER 37

Charakterisierung der elektrischen Eigenschaften von Korngrenzen an polykristallinen Chalkopyriten — •Sebastian Linke, Thorsten Rissom, Daniel Abou-Ras, Martha Ch. Lux-Steiner und Sascha Sadewasser — Helmholtz-Zentrum für Materialien und Energie, Hahn-Meitner-Platz 1, 14109 Berlin

Polykristalline $CuIn_{1-x}Ga_xSe_2$ (CIGSe) Absorberschichten bilden die Grundlage der Dünnschicht-Solarzellen mit dem momentan höchsten Wirkungsgrad. Eine Besonderheit ist, dass polykristalline CIGSe Solarzellen, im Gegensatz zu Dünnschichtzellen auf Siliziumbasis, höhere Wirkungsgrade als die monokristallinen Pendants erzielen. Die Gründe dafür sind Gegenstand aktueller Forschung. Der Einfluß der Korngrenzen auf den Ladungstransport, insbesondere in Abhängigkeit vom [Ga]/[Ga+In]-Verhältnis, ist hierbei von großem Interesse. Die Charakterisierung der elektrischen Eigenschaften der Korngrenzen ist Voraussetzung, um ein besseres Verständnis der hohen Wirkungsgrade (> 20%) polykristalliner Absorber zu erhalten. Wir präsentieren Untersuchungen polykristalliner $CuInSe_2$ sowie $CuIn_{0.67}Ga_{0.33}Se_2$ Absorberschichten mittels Rastertunnelspektroskopie (STS) im Ultrahochvakuum bei Raumtemperatur, sowohl im Dunkeln als auch unter Beleuchtung. Bestimmte Korngrenzen zeigen im Vergleich zu ihrer direkten Umgebung eine reduzierte Dichte an Defektzuständen innerhalb der Bandlücke. Dies ist eine mögliche Erklärung für die herausragende Effizienz polykristalliner CIGSe Solarzellen. Unter Beleuchtung nimmt die differentielle Leitfähigkeit ab. Desweiteren wurden Strukturuntersuchungen mittels Elektronenbeugung (EBSD) durchgeführt.

HL 24.3 Mon 16:30 GER 37

Analysis of $Cu_2ZnSn(S/Se)_4$ by Photoluminescence and Raman — •Rabie Djemour, Levent Gütay, and Susanne Siebentritt — Laboratory for Photovoltaics, University of Luxembourg

Kesterites $Cu_2ZnSn(S/Se)_4$ are promising absorber materials for low cost thin film photovoltaic devices, since they are composed of cheap, abundant, and non toxic materials. However, growing single phase $Cu_2ZnSn(S/Se)_4$, turns out to be a difficult task because of the very small existence region, as shown experimentally and theoretically. Thus, for proper optimization of the growth process of kesterites it is essential to detect the occurrence of any secondary phase. Since conventional X-ray diffraction and energy dispersive X-ray analysis are lacking unambiguous phase resolution, we perform photoluminsecence (PL) and Raman measurements, which allow for non-ambiguous identification of the kesterite and co-existing secondary phases. We present a homebuilt system that allows PL and Raman measurements at the same spot with a spatial resolution in the one micron range. We show and discuss characteristic PL spectra for kesterites of different composition and varying crystal quality and demonstrate that even single crystals show compositional and opto-electronic inhomogeneities.

HL 24.4 Mon 16:45 GER 37

Influence of band-gap grading on luminescence properties of Cu(In,Ga)Se_2 — •Jakob Haarstrich[1], Heiner Metzner[1], Carsten Ronning[1], Thorsten Rissom[2], Christian A. Kaufmann[2], Hans-Werner Schock[2], and Andreas Undisz[3] — [1]Institut für Festkörperphysik, Friedrich Schiller Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Solar Energy Research, Institute for Technology, Lise-Meitner-Campus, Hahn-Meitner-Platz 1, 14109 Berlin, Germany — [3]Institute for Material Science and Technology, Metallic Materials, Friedrich-Schiller-University Jena, Loebdergraben 32, 07743 Jena, Germany

Cathodoluminescence (CL) has been measured on Cu(In,Ga)Se_2 with Ga-grading as it is used in high-efficiency thin-film solar cells at 10 K in both cross-section and plain view configuration. In cross-section geometry, we show that the vertical profile of the emission energy represents the Ga-profile in the film and, thus, we are able to measure the band-gap grading present by means of CL methods. At the same time, we observe a strong drift of excited charge carriers towards the minimum of the band-gap which can be explained by the Ga-grading. It is shown by voltage-dependent CL, how these results directly influence the interpretation of luminescence spectra obtained on Ga-graded Cu(In,Ga)Se_2 and, thus, they will have to be considered as a basis for all forthcoming investigations on this topic.

HL 24.5 Mon 17:00 GER 37

Pump-probe investigations on thin film ablation with ultrashort laser pulses — •Matthias Domke, Gerhard Heise, and Heinz Huber — Hochschule München

Laser lift-off processes have been observed during structuring CIGS thin film solar cells. To get a deeper insight in the underlying physical processes a pump-probe setup is used for spatial and temporal investigation of the interaction of ultra-short laser pulses with thin films. The setup consists of a 10 ps-laser pulse at a wavelength of 1064 nm that is split up into a pump and a probe beam. The pump beam is used to ablate thin films with single or multiple pulses. The probe beam illuminates the ablation area after an optically or electronically defined delay. A CCD Camera behind a microscope objective captures an image of the ultra-short exposed region. The probe beam is frequency doubled so that the pump light may be filtered out at the camera. Thus, the development of multiple pulse ablation is investigated in situ by taking pictures after each single pulse. Furthermore, a series of pictures can be taken on a picosecond time-scale by increasing the temporal delay of pump and probe beam. Consequently, the temporal evolution of direct and indirect (lift off) laser ablation of thin films can be studied.

HL 24.6 Mon 17:15 GER 37

Spectroscopic Imaging ellipsometry on arsenic sulphide fibers with a lateral resolution down to one micrometer — •Peter H Thiesen and Christian Röling — Accurion GmbH, Stresemannstr. 30, 37079 Göttingen

The cross section of three different arsenic sulphide fibers with different core diameters and different core/clad ratios were characterized. Ellipsometric contrast micrographs were recorded; wavelength spectra between 360 and 1000 nm at different regions of interest (ROI) and maps with a lateral resolution down to 1 micrometer of Delta and Psi were measured. The optical dispersion of the samples was described by a layer stack including an arsenic sulphide substrate, a roughness layer and air as ambient. The optical dispersion of arsenic sulphide was expressed by a Tauc-Lorentz function and the roughness layer by an effective medium approach. For the transformation of Delta and Psi maps to maps of thickness of roughness layers and maps of refractive index, the Tauc-Lorentz function was substituted by n and k as fitting parameters. Maps of refractive index and of thickness of roughness layer were obtained. Position dependent optical properties of cross sections of arsenic sulphide fibres, with core diameters down to few micrometers, can be characterized by spectroscopic imaging ellipsometry. Refractive index maps were obtained for selected wavelengths with a lateral resolution better than one micrometer.