HL 23: Joint Focussed Session: Thin Film Chalcogenide Photovoltaics II

Time: Monday 14:45–15:45 Location: GER 37

Topical Talk HL 23.1 Mon 14:45 GER 37

Dünnschicht-Chalkogenid-Solarzellen: Überblick und Forschungsfelder — •Michael Powalla — Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg

Unter allen Dünnschichtsolarzellenkonzepten bietet die sogenannte CIGS-Technologie (Copper, Indium, Gallium, Selenium, Sulfur) das höchste Kostenreduktionspotenzial in der industriellen Fertigung. Dies ist begründet in dem im Labor nachgewiesenen hohen Wirkungsgradpotenzial, welches vergleichbar mit Solarzellen aus polykristallinem Silizium ist.

Der Vortrag gibt einen Überblick über den Stand der Entwicklung der CIGS-Solarzellen und -module in der Industrie und der Forschung. Ein Fokus liegt dabei auf der Licht absorbierenden, p-halbleitenden CIGS-Schicht, der Grenzfläche und dem n-leitenden Heterokontaktpartner. Die CIGS-Schicht wird mittels thermischer Koverdampfung oder in einem sequentiellen Verfahren hergestellt. Für den n-leitenden Frontkontakt werden unterschiedliche II/VI-Materialien verwendet, die sowohl im chemischen Bad als auch von der Gasphase abgeschieden werden können.

Am ZSW wird eine Kleinzellenlinie sowie eine Modullinie (Glassubstrate bis 30 cm x 30 cm) zur Herstellung von CIGS-Solarzellen betrieben. Speziell für flexible Substratträger (Polyimid, Metallfolien) werden Beschichtungen auf einer Rolle-zu-Rolle-Beschichtungsanlage durchgeführt. Aktuelle Forschungsergebnisse wie z. B. die Erreichung des weltbesten Wirkungsgrades für Dünnschichtsolarzellen von 20,3 % mit einer CIGS/CdS-Diode werden präsentiert.

HL 23.2 Mon 15:15 GER 37

Thin film solar cells based on the ternary compound Cu_2SnS_3 — •Dominik M. Berg, Phillip J. Dale, and Susanne Siebentritt — University of Luxembourg, Laboratory for Photovoltaics, 41 rue du Brill, L-4422 Belvaux, Luxembourg

Thin films of kesterite ($Cu_2ZnSn(S/Se)_4$) semiconductors are considered promising absorber layer materials for low cost thin film photovoltaic devices. Experimental and theoretical investigations show, however, that the existence region of a single phase kesterite is relatively small making it difficult to grow single phase absorbers. The semiconducting compound Cu_2SnS_3 is a common secondary phase that forms in Cu and Sn rich kesterite thin films during growth. Its appearance in a kesterite device would limit the V_{OC} due to its smaller band gap. However, the band gap of about 1 eV, reported hole concentrations of 10^{18} cm^{-3}, and an absorption coefficient in the visible region of 10^5 cm^{-1} make the Cu_2SnS_3 compound itself a promising candidate for low cost photovoltaic applications.

In this report we demonstrate the successful fabrication of a thin film solar cell based on Cu_2SnS_3 via a precursor annealing process. The precursor is prepared by low cost electrodeposition. A maximum external quantum efficiency of about 60% at 800 nm and a band gap of 1.0 eV could be measured. To the best of our knowledge, there have been no other reports on the fabrication of Cu_2SnS_3 based solar cell devices so far. Loss mechanisms and ways to increase efficiency will be discussed.

HL 23.3 Mon 15:30 GER 37

Investigation of lattice defects and compositional gradients in $Cu(In,Ga)Se_2$ thin films for solar cells — •Jens Dietrich[1], Daniel Abou-Ras[2], Thorsten Rissom[2], Thomas Unold[2], Hans-Werner Schock[2], and Christian Boit[1] — [1]Department of Semiconductor Devices, Berlin University of Technology, Einsteinufer 19, 10587 Berlin — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Hahn-Meitner-Platz 1, 14109 Berlin

$Cu(In,Ga)Se_2$ absorber layers used in thin-film solar cells exhibit, when grown in a multi-stage process, compositional gradients of gallium and indium, dependent on process parameters such as the Ga content. The high lateral resolution of transmission electron microscopy (TEM) imaging and energy-dispersive X-ray spectroscopy (EDX) allows the determination of lattice defects and the elemental concentrations at identical sample positions. Cross-sectional TEM samples of $ZnO/CdS/Cu(In,Ga)Se_2/Mo$/glass stacks were prepared with varying [Ga]/([In]+[Ga]) ratio in the absorber. The shape of the Ga distribution was measured by means of EDX and differs for the various [Ga]/([In]+[Ga]) ratios. Linear (dislocations) and planar defects (stacking faults, microtwins) were studied by means of TEM bright field and dark field images along the lengths of the $Cu(In,Ga)Se_2$ layers. Strong Ga compositional gradients were found even within individual grains. It appears that these Ga gradients correlate with the occurrence of dislocation networks in large grains (diameter $> 1\,\mu$m). We assume that these dislocations compensate for lattice mismatch due to the change in composition in this area of the lattice.