DS 5: Thin film photovoltaics: CIGSe + CdTe

Time: Monday 10:00–11:00 Location: H 2032

DS 5.1 Mon 10:00 H 2032

Diffusion of Zn in solar-grade Cu(In,Ga)Se_2 and single-crystal $CuInSe_2$ thin films — Jens Bastek[1], Roland Würz[2], Jürgen Albert[3], Sascha Sadewasser[3], and •Nico Stolwijk[1] — [1]Universität Münster, Institut für Materialphysik, 48149 Münster — [2]Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg, 70565 Stuttgart — [3]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, 14109 Berlin

The diffusion behaviour of Zn in polycrystalline CIGSe is found to be very similar to that in monocrystalline CISe, which indicates that grain boundaries only play a minor role as segregation sites and fast-transport pathways. The Zn diffusion coefficient shows a slightly stronger temperature dependence than Cd in CIGSe while its values are lower by about one order of magnitude. Surprisingly, the diffusion profiles exhibit peculiar shapes with a second maximum near the CI(G)Se-substrate interface. Zn may be relevant to CIGS technology as it is a major component of the transparent oxide layer. In addition, Zn may penetrate into the active zone during solar-cell processing when the CdS buffer layer is replaced by ZnS. The present results were obtained from diffusion experiments with the radiotracer Zn-65 using lamp-oven annealing followed by ion-beam sputter-sectioning. We will discuss possible implications with regard to diffusion mechanisms and site occupancy.

DS 5.2 Mon 10:15 H 2032

Strongly Confined and Chemically Flexible Grain Boundaries in Cu(In,Ga)Se_2 Thin Films — Daniel Abou-Ras[1], Sebastian S. Schmidt[1], •Raquel Caballero[1,2], Thomas Unold[1], Hans-Werner Schock[1], Christoph T. Koch[3], Bernhard Schaffer[4], Miroslava Schaffer[4], Oana Cojocaru-Mirédin[5], and Pyuck-Pa Choi[5] — [1]HZB, Berlin, Germany — [2]UAM, Madrid, Spain — [3]Ulm University, Germany — [4]SuperSTEM, UK — [5]MPI for Iron Research, Düsseldorf, Germany

In the present work, we will show by means of electron holography, EFTEM and APT with spatial resolutions in the subnanometer range that substantial changes in composition with respect to the grain interiors are found at GBs in Cu(In,Ga)Se_2 (CIGSe) thin films within only about 1 nm wide regions. At Se-cation terminated twin boundaries, Cu depletion was measured, whereas considerable In enrichment and Cu depletion are visible in EFTEM maps of the Se/Se-terminated twins. At random GBs, Cu enrichment and In depletion as well as Cu depletion and In enrichment were found. Often, also enhanced Na, O, and K signals are detected at random GBs. Although no general compositional change at random CIGSe GBs was identified , the trends in Cu and In concentrations were always anticorrelated. These results suggest mechanisms of atomic/ionic redistribution at twin boundaries and random GBs, occurring within regions confined to only about 1 nm in width around the GBs, being also influenced by the trace elements segregated to the GBs. The apparent anticorrelation of Cu and In signals suggests a preferential site exchange of Cu and In atoms.

DS 5.3 Mon 10:30 H 2032

Investigation of the chlorine A-Center in polycrystalline CdTe layers by photoluminescence spectroscopy — •Christian Kraft[1], Heiner Metzner[1], Mathias Hädrich[1], Pascal Schley[2], and Rüdiger Goldhahn[3] — [1]Institut für Festkörperphysik, Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany — [2]Institut für Physik, Technische Universität Ilmenau, 98684 Ilmenau, Germany — [3]Institut für Experimentelle Physik, Universität Magdeburg, 39016 Magdeburg, Germany

Polycrystalline CdTe is a well known absorber material for thin film solar cells. However, the improvement of CdTe-based solar cells for industrial application is mainly based on empirical enhancements of certain process steps which are not concerning the absorber itself. Hence, the defect structure of CdTe is still not understood in detail. One of the most discussed defects in CdTe is the so called chlorine A-center. In general, the A-Center describes a defect complex of the intrinsic cadmium vacancy defect and an extrinsic impurity. By means of photoluminescence spectroscopy at temperatures of 5 K we investigated the behavior of the chlorine A-center under different CdTe activation techniques. Therefore, we were able to determine the electronic level of that defect and to analyze its influence on the crystal quality and the functionality of solar cells that were prepared of the corresponding samples.

DS 5.4 Mon 10:45 H 2032

Impedance Spectroscopy of CdTe Thin Film Solar Cells — •Charlotte Weiss, Christoph Heisler, Udo Reislöhner, Carsten Ronning, and Werner Wesch — Institute of Solid State Physics, University of Jena, Max-Wien-Platz 1, D-07743 Jena

Impedance Spectroscopy (IS) is a widely used method to analyze dielectric properties of specimen as a function of frequency. Typically this characterization method delivers an equivalent circuit diagram of the device under examination to describe its electrical properties. Traditionally IS is used in coating evaluation, corrosion monitoring and in electrochemistry. During the last years the method became more important also in the field of electrical characterization of solar cells.

In our work we use IS for the electrical characterization of thin film CdTe solar cells. The measurement is done at room temperature without illumination in a frequency domain from 20Hz to 2MHz. The samples are measured under variable forward bias. The results match insufficiently with the model of two resistor-capacitor circuits in series which is commonly used to describe the p-n junction and the blocking back contact. For better consistency, other models from the literature are used and discussed. From the results a conclusion is drawn about the properties of the solar cell such as the nature of the p-n junction or the performance of the back contact.