

MM 39: Topical Session Photovoltaic Materials III

Time: Wednesday 14:45–15:45

Location: H4

MM 39.1 Wed 14:45 H4

Influence of interface preparation on minority carrier lifetime for low bandgap tandem solar cell materials — ●NADINE SZABÓ, B. EROL SAGOL, ULF SEIDEL, KLAUS SCHWARZBURG, and THOMAS HANNAPPEL — Helmholtz-Zentrum Berlin für Materialien und Energie GmbH Hahn-Meitner-Platz 1 14109 Berlin

III-V semiconductor compounds grown by MOVPE are implemented in today's state-of-the-art third generation multi-junction solar cells. The current record multi junction solar cell grown on germanium, having Ge, Ga(In)As and GaInP as subcells, reached a record efficiency of 41.6%. The efficiency of these multi junction solar cells could be significantly increased, if its low bandgap Ge subcell would be replaced by a more efficient tandem. For this purpose the low bandgap materials InGaAs and InGaAsP are suitable. The bandgap composition of these materials allows a better yield of the solar spectrum. Based on InGaAs/InGaAsP absorber materials we have developed a low bandgap tandem solar cell with optimized bandgaps. Results of time resolved photoluminescence (TRPL) for the IR-bandgap compounds InGaAsP (1.03 eV) / InGaAs (0.73 eV) will be presented. The lifetime of minority carriers is one of the most important properties of solar cell absorber materials. We show on the example of the low band gap tandem cell how the choice of the materials, the quality of the bulk, the optimization of the band gap energies and the preparation of the critical interfaces are essential to build a high efficiency solar cell. The quality of the bulk and the preparation of the critical interfaces are essential for the growth of the double hetero structure (DHS).

MM 39.2 Wed 15:00 H4

Sulfosalt Gradient Layers for Photovoltaic Applications — ●HERBERT DITTRICH, DAN TOPA, ANDREAS STADLER, JOHANNES STÖLLINGER, ASTRID PACHLER, and GERHARD AIGNER — Christian Doppler Labor ASEC, Universität Salzburg, Hellbrunner Str. 34, 5020 Salzburg, Österreich

Sulfosalts have demonstrated to be an important compound semiconductor family including more than 260 members. They are characterized by a complex chemistry and crystal structure. In this contribution the deposition of Sn-Sb-S gradient layers and their physical properties with respect to photovoltaic applications will be presented.

Sn-Sb-S gradient layers were deposited by magnetron sputtering from inhomogeneous targets on pure glass substrates and substrates covered with a Mo electrode layer as used in CIGS technology. Chemical analysis was carried out by electron microprobe analysis and results were combined in concentration maps over the substrate area. In correlation to the chemical composition, the structural aspects of the layers were measured by X-ray powder diffraction. The absorption coefficient, optical bandgap, resistivity, conduction type and the Seebeck coefficient of the sulfosalt layers were measured and, again, correlated to the chemical composition and the crystal structure.

Results will be discussed with respect to thin film solar cell applications.

MM 39.3 Wed 15:15 H4

Real-time investigations on the formation reactions in the system Cu-Sn-S — ●ROLAND SCHURR, ASTRID HÖLZING, and RAINER HOCK — Lehrstuhl für Kristallographie und Strukturphysik, Universität Erlangen-Nürnberg, Staudtstraße 3, D-91058 Erlangen

The quaternary compound kesterite $\text{Cu}_2\text{ZnSnS}_4$ (CZTS) is a promising candidate for the production of low-cost thin film solar cells. CZTS thin film solar cells with efficiencies of up to 6.77% were produced [1].

The understanding of the recurrent formation reactions in the system Cu-Zn-Sn-S is necessary for the optimization of CZTS absorbers and the development of low-cost thin film solar cells. In a previous publication we presented the formation of CZTS thin film solar cell absorbers from co-electroplated precursors depending on the metal ratios in the as deposited films [2]. The crystallisation of CZTS is completed by the reaction of Cu_2SnS_3 and ZnS. Further reactions mainly involved are the formation of binary and ternary Cu-Sn sulfides. Due to the phase diagrams of Olekseyuk et al. [3] of the ZnS-SnS₂ and Cu₂S-ZnS systems, the system Cu₂S-SnS₂ forms Cu-Sn sulfides at low temperatures. Real-time investigations on the formation reactions in the ternary subsystems of Cu-Zn-Sn-S while annealing stacked elemental layers provide the reaction paths of the binary and ternary sulfides.

In the present work we report on results of in-situ XRD experiments on the formation mechanisms with main focus on the Cu-Sn-S system.

[1] H. Katagiri et al., Appl. Phys. Express 1 (2008) 041201

[2] R. Schurr et al., Thin Solid Films 237 (2009) 2465

[3] I.D. Olekseyuk et al., J. Alloys Compd. 368 (2004) 135

MM 39.4 Wed 15:30 H4

Neutron diffraction investigations of kesterites: cation order and disorder — ●SUSAN SCHORR¹, MICHAEL TOVAR², SERGEJ LEVCENCO³, ALEXANDER NAPETROV³, and ERNEST ARUSHANOV³ — ¹Free University Berlin, Institute of Geological Sciences, Germany — ²Helmholtz Zentrum Berlin für Materialien und Energie, Germany — ³Academy of Sciences of Moldova Republic, Institute of Applied Physics, Chisinau, Moldova

The quaternary chalcogenides $\text{Cu}_2\text{ZnSnS}_4$ and $\text{Cu}_2\text{ZnSnSe}_4$ have newly attracted attention as possible absorber materials in thin film solar cells.

They crystallize in the kesterite type (space group $I\bar{4}$) or stannite type structure (space group $I\bar{4}2m$), which are described as an ordered distribution of the cations on different structural sites. Cation disorder may cause site defects and hence influences the electronic properties of the material. Thus the degree of cation order/disorder plays a crucial role and was therefore in the focus of the presented investigations. A differentiation between the isoelectronic cations Cu^+ and Zn^{2+} is not possible using X-ray diffraction due to their similar scattering power. But their neutron scattering lengths are different, thus neutron diffraction opens the possibility to determine the cation distribution in these compounds. A simultaneous Rietveld analysis of neutron and X-ray powder diffraction data revealed that in dependence on the thermal history of the samples cation disorder appears. The correlation trend between cation order/disorder and the sample growth method (solid state synthesis, Bridgmann method) will be discussed.