POST DEPOSITION ANNEALING EFFECT ON PROPERTIES OF CDS FILMS AND ITS IMPACT ON CDS/Sb_2Se_3 SOLAR CELL PERDORMANCE

Sajeesh Vadakkedath Gopi [1], Nicolae Spalatu [1], Madhawa Basnayaka [1], Robert Krautmann [1], Atanas Katerski [1], Raavo Josepson [2], Raitis Grzibovskis [3], Aivars Vembris [3], Malle Krunks [2], Ilona Oja Acik [1]*

[1] Department of Materials and Environmental Technology, Tallinn University of Technology, Ehitajate tee 5, Tallinn Estonia

[2] Division of Physics, Tallinn University of Technology, Ehitajate Tee 5, 19086 Tallinn, Estonia

[3] Institute of Solid State Physics, University of Latvia, Kengaraga Str. 8, Riga, Latvia

e-mail of presenting author: savada@ttu.ee

Antimony selenide (Sb_2Se_3) is one of the emerging photovoltaic absorber materials possessing abundance and non-toxicity as the main attributes. Following CdTe technology [1], CdS is a widely used partner layer for Sb_2Se_3 solar cells. Related to CdS/Sb_2Se_3 device configuration, a number of studies reported findings and challenges regarding the intermixing phenomenon at the main interface and suitability of various annealing for CdS (and related interface) and still, significant room remains in developing strategies for interface optimization and understanding of the physiochemistry behind [2]. In this perspective, this work provides a systematic investigation of the effect of vacuum and air annealing at temperatures between 200 and 400 °C on the properties of CdS deposited by chemical bath deposition and combined with Sb_2Se_3 absorber obtained by close-spaced sublimation the direct impact of the CdS annealing on the device performance is illustrated. It is found that by varying the annealing temperature from 200 to 400 °C in both, vacuum and air ambient, the morphology of CdS changes from highly dispersed small grain structure to sintered dense grains, the band gap decreases from 2.43 to 2.35 eV and the electron density drops from ~10^{18} to ~10^{11} cm^{-3}. These changes were correlated with the changes in the CdS lattice and connected with the mobility of the OH group and the presence of secondary phases in CdS layers. 200 °C air annealing of CdS was found as an optimal treatment resulting in 2.8% Sb_2Se_3/CdS cell efficiency - a 60% boost compared to the 1.8% performance of the device with as-deposited CdS. Material and device characterization analysis is performed, providing complementary insights on the interrelation between the physicochemical mechanism of the CdS annealing processes and device functionality.

References

1. N. Maticiuc, N. Spalatu, V. Mikli, J. Hiie. 2015, Appl. Surf. Sci. 350, 14-8.
2. R. Tang, Z. H. Zheng, Z. H. Su, X. Li et al. (2019). Nano Energy. 2019.103929.

Euroopa Liit
Euroopa
Regionaalarengu Fond

Eesti
tuleviku heaks