ANALYSIS OF GRAIN ORIENTATION AND DEFECTS IN Sb_2Se_3 SOLAR CELLS FABRICATED BY CLOSE-SPACED SUBLIMATION

Robert Krautmann [a], Nicolae Spalatu [a], Rene Gunder [b], Daniel Abou-Ras [b], Thomas Unold [b], Susan Schorr [b c], Ilona Oja Acik [a] and Malle Krunks [a]

a Department of Materials Technology, Tallinn University of Technology
Ehitajate tee 5, 19086 Tallinn Estonia
b Helmholtz-Zentrum Berlin for Materials and Energy,
Hahn-Meitner Platz 1, 14109, Berlin, Germany
c Freie University Berlin, Institute of Geological Sciences,
Malteserstr. 74-100, Berlin, Germany

Author to whom correspondence should be addressed: robert.krautmann@taltech.ee:

Sb_2Se_3 has emerged as a potential future photovoltaic (PV) absorber material exhibiting suitable optical and electronic properties. Despite rapid increase in device efficiency, Sb_2Se_3 solar cells still perform far below their theoretical efficiency. Undesired grain growth and deep defects are some of the most discussed factors that limit the device performance. While substrate solar cells seem to benefit from structures that comprise vertical Sb_2Se_3 ribbons, superstrate solar cells have so far performed better with dense structures of large grains. Here, we present a superstrate TiO_2/Sb_2Se_3 solar cell, which was fabricated by close-spaced sublimation technique (CSS) and which included the deployment of seed layer to influence Sb_2Se_3 absorber growth. This study aimed to inspect the ordering of Sb_2Se_3 grains more closely to evaluate its effect on the device performance. It was found that seed layer deployment enabled growth of larger columnar Sb_2Se_3 grains, but also increased presence of favorable crystal planes. Although subsequent pole figures measured by XRD and orientation distribution maps performed by electron backscatter diffraction (EBSD) did not detect strong preferred orientation, the results indicated that scaling up the columnar Sb_2Se_3 growth has the potential to further consolidate texture along the [001] direction. Columnar microstructure enhanced by seed layer was also attributed to clear improvement in the Sb_2Se_3 device performance. Capacitance-voltage (CV) profiling and temperature-dependent admittance spectroscopy (TAS) were then performed on the seed-assisted TiO_2/Sb_2Se_3 solar cell to evaluate carrier density and deep defects in the Sb_2Se_3 absorber. Thus, we discussed the influence of both structural and optoelectronic properties on the Sb_2Se_3 solar cell performance and provided potential pathways for boosting device efficiency.

Euroopa Liit
Euroopa
Regionaalarengu Fond

Eesti
tuleviku heaks