Accepted Manuscript

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J. Krc, M. Sever, A. Campa, Z. Lokar, B. Lipovsek, M. Topic

PII: S0040-6090(16)30496-5
DOI: doi: 10.1016/j.tsf.2016.08.056
Reference: TSF 35437

To appear in: *Thin Solid Films*

Received date: 2 June 2016
Revised date: 22 August 2016
Accepted date: 24 August 2016

Please cite this article as: J. Krc, M. Sever, A. Campa, Z. Lokar, B. Lipovsek, M. Topic, Optical confinement in chalcopyrite based solar cells, *Thin Solid Films* (2016), doi: 10.1016/j.tsf.2016.08.056

OPTICAL CONFINEMENT IN CHALCOPYRITE BASED SOLAR CELLS

J. Krc, M. Sever, A. Campa, Z. Lokar, B. Lipovsek, and M. Topic

University of Ljubljana, Faculty of Electrical Engineering

Trzaska 25, 1000 Ljubljana, Slovenia

ABSTRACT

Potential gains in short-circuit current density related to improvements in optical confinement in chalcopyrite based solar cells are studied and quantified by means of optical simulations. In the first part idealized optical conditions – anti-reflection at front interfaces, high reflection at back contact and light scattering – are introduced by simulating realistic scenarios of Cu(In, Ga)Se_2 (CIGS) solar cells with 2000 nm thick and 300 nm ultra-thin CIGS absorber, including the encapsulation at the front. For anti-reflection effect at front interfaces simulations revealed that in the photovoltaic module structure the most critical reflectance is the reflectance of the front surface of the protecting glass (possible 4.4 % gain in short-circuit current density) and not the one at the front transparent conductive oxide contact, as in the case of non-encapsulated solar cell. Introduction of a highly reflective, highly diffusive back reflector is the most crucial point to improve the short-circuit current density of the ultra-thin devices. Potential for 15.8 % gain in short-circuit current density related to ideal reflectance and additional 17.4 % related to ideal scattering introduced at the back contact was revealed. A concrete example of light management structure was investigated in the second part by employing fully three-dimensional rigorous optical simulations. A semi-ellipsoidal texture was introduced to the substrate of the ultra-thin device. By using ZrN back reflector in simulations the gains in short-circuit current density related to the optimised size of the