Photoelectrical Properties of CdS/CdMgTe Heterostructure for Tandem Solar Cells

T.I. Mykytyuk [1], I.M. Fodchuk [1], V.V. Kulchynsky [1], O.L. Maslyanchuk [1] X. Mathew [2]

[1] *Chernivtsi National University, 2 Kotsyubinsky Str., Chernivtsi 58012, Ukraine*
[2] *Instituto de Energías Renovables, Universidad Nacional Autonoma de Mexico, Temixco, Morelos 62580, México*

For several decades, solar cells based on CdTe keep a stable position in thin-film photovoltaics as an alternative to solar modules based on mono- and poly-silicon wafers. Thin film tandem solar cells are one of alternative way for increasing solar cells efficiency. Many experts in the field of photovoltaic considered that thin film CdS/CdMgTe heterostructure with an absorbing layer of CdMgTe one of the most promising semiconductor materials for developing the top sub-cell in a tandem device [1,2]. For the above top-cell, a suitable absorber material for the bottom sub-cell can be the well-studied CIGS and $Hg_xCd_{1-x}Te$ alloys with a bandgap in the range of 1-1.1 eV. $Cd_{1-x}Mg_xTe$ is an alloy of MgTe and CdTe and can be made with a wide tolerance to variations of Cd/Mg ratio, when the semiconductor bandgap varies continuously with *x* from about 1.5 eV for CdTe to about 3.5 eV for MgTe. Whatever the material composition, $Cd_{1-x}Mg_xTe$ is a direct-bandgap semiconductor and strongly absorbs sunlight. Because of this, a much thinner film in CdMgTe-based solar devices is required than of other indirect-bandgap semiconductor materials. In this case important to take into account physical factors which occurs when thinning absorber layer, such as: decrease in absorptive capacity, recombination losses at the surfaces and in the space charge region of p-n heterojunction.

The analysis is complicated by the fact that transmission spectra of the CdS/CdMgTe layers differ from the spectra of monolithic thin-film structures since the reflection coefficients at the interfaces: semiconductor/air and semiconductor/semiconductor can vary significantly. This problem can be solved by calculations based on the optical constants of materials that take into account reflections from all interfaces and absorption in the materials.

This paper presents calculations which gives quantitative description of the spectral distribution of the quantum efficiency of CdS/CdMgTe heterostructure. A theoretical analysis of the optical and recombination losses in thin film CdS/CdMgTe solar cells and its impact on short-circuit current are carried out. Our results show, at which thickness of the absorber layer and the width of the space-charge region the limiting factors can be ignored. The spectra of the optical transmission the CdS/CdMgTe structure with taking into account optical constants dependencies have been calculated**.** Quantum efficiency the CdS/CdMgTe solar cell and the losses due to the recombination of charge carriers at the front and back surfaces of the absorbing layer, in its neutral part and in the space charge region of p-n heterojunction have been determined.

[1] S. Omar, A. Martínez, L. Remolina, G. Huerta, N.R. Santana, M. Mathews, L. Ramon-Garcia, E.R. Morales, X. Mathew, *Materials Chemistry and Physics*, **132**, 559 (2012).
[2] X. Mathew, J. Drayton, V. Parikh, N.R. Mathews, Xiangxin Liu, A.D. Compaan, *Semiconductor Science and Technology*, **24**, 015012 (2009).