Annals of the Academy of Romanian Scientists
Edition ONLINE Physics series
ISSN 2066-8589 Volume **1**, Number **1/2009**

QUANTUM CONFINEMENT MODELING AND SIMULATION FOR QUANTUM WELL SOLAR CELLS

Laurențiu FARA[1], Vladimir IANCU[1], Mihai Răzvan MITROI[1]

Abstract. *The present paper discusses the modeling of the multi-layered quantum well solar cells as well as the simulated results of this model. The quantum confinement of a semiconductor induces new energy levels, located in the band gap, as well as resonant levels located in the conduction and valence bands. These levels allow supplementary absorption in visible and near infrared range. The quantum efficiency of the supplementary absorption was calculated within the infinite rectangular quantum well approximation. As the absorption excites carriers in the gap of each layer, even a small absorption significantly increases the photocurrent (by photoassisted tunneling) and therefore the cell efficiency. There are presented the results of the simulation for Einstein absorption coefficient and quantum efficiency of the transition between the resonant levels of GaAs, as well as quantum efficiency of the transitions between the confinement levels.*

Keywords: Solar cell; Quantum Confinement Effects; Multi-layered structure; Optical Absorption; Quantum Well

1. Introduction

The "quantum well" photovoltaic cells were first proposed in 1990 [1], based on the idea that the use of the quantum wells could improve the photovoltaic cells by extending their spectral response, as well as by increasing the photocurrent. One year later, this idea was experimentally proved by using a $GaAs/Al_xGa_{1-x}As$ multi-layered structure [2]. From then on, the use of the multi-layered photovoltaic (MLPV) cells became one of the most used approaches for a high efficiency PV cell. Generally, such cells are p-i-n type diodes, with the intrinsic region formed by a multilayered structure [3-15]. Most of these cells have layers of tens or even hundreds of nanometer thickness, so that the quantum effects are reduced; nevertheless they are also called in some texts "quantum well" PV cells (see for instance Ref. 5). However, MLPV cells with real quantum sizes (multi-layered quantum well photovoltaic – MLQWPV) are also studied (e.g. in Refs. 14, 15).

The E 2456-06 ASTM International Standard "Terminology for Nanotechnology" states that sizes between 0.1 and 1 μm are to be called "submicronic", while the prefix "nano" is to be used for sizes between 1 and 100 nm only. On the other hand, an analysis of the quantum effects proves that the quantum size appears under about 20 interatomic distances (e.g. about 5 nm), where the band structure

[1]Faculty of Applied Sciences, University „Politehnica" of Bucharest, 313 Splaiul Independenței Bucharest, 060042, Romania.