PHOTOVOLTAGE FORMATION UNDER HIGH CONCENTRATED LIGHT ACROSS GAAS P-N JUNCTION

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The Shockley-Queisser (SQ) theory defines the limit of theoretical possible efficiency of a single junction solar cell under illumination of one Sun with an AM 1.5G spectrum standard [1]. The essence of the SQ theory is based on the statement that only photons with energy equal or higher than the band gap of the semiconductor can generate an electron-hole pair and the photons with energy less than the band gap don‘t involve in the formation to the photoresponse of the solar cells.

Our investigation is based on the assumption that the in formation of photovoltage of the solar cells should be included photons with energies less than the semiconductor band gap as well as those of large energy through the hot carrier phenomenon before the thermalisation process. In this case, for GaAs calculations reveal that 33.0% can be supplied to heat carriers by the low energy photons and 21.7% by the high energy photons of the total AM 1.5 G solar radiation.

The object of investigation is GaAs p-n junction as known for its relatively expressed two-photon absorption [2]. The object was illuminated by laser light with a maximum intensity of 10 MW/cm^2, a pulse duration of 25 ns and a photon energy of 1.16 eV which is less than the band gap of GaAs 1.42 eV. In this case, the process of electron-hole pair generation occurs only through two-photon absorption, and the carrier heating process happens due to the intraband absorption.

As for conclusion, the negative effect of hot carriers has to be reduced to raise the efficiency of solar cells.

[1] W. Shockley and H. J. Queisser, Detailed balance limit of efficiency of p–n junction solar cells, J. Appl. Phys. 32, 510-519, (1961).

[2] W. Hurlbut, Y. Lee, et al., Multiphoton absorption and nonlinear refraction of GaAs in the mid-infrared, Opt. Lett. 32, 668–670, (2007).