Identification of Recombination Centers in the CdTe-based Solar Cells by Means of PL-T and PL-V Techniques

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It is well known that photoluminescence emission and nonradiative recombination through traps or recombination centers compete with current extraction and power production in a solar cell. Therefore for the improvement of a solar cell efficiency, it is crucial to identify the origin and parameters of recombination centers present in its absorber layer.

In this article the results of investigations of recombination centers in photovoltaic structures based on CdTe grown by the MBE technique have been presented. For the identification of recombination centers in the studied junctions the temperature- and bias-dependent photoluminescence (PL-T and PL-V) methods have been applied. In these experiments He-Ne (633 nm) laser was used. The PL-T measurements have been performed in the temperature range from 20 – 300 K, whereas the bias-dependent at a temperature of 12K.The analysis of photoluminescence experiments revealed the presence of recombination centers in the absorber layers of investigated samples. Two types of optical transitions were observed in the PL spectra, labeled as A and B (cf. Fig. 1). It has been found that their activation energies of ~ 6 and 11 meV correspond to the free excitons and donor-acceptor pair radiative recombination, respectively [1]. The PL-V measurements revealed the bias-evolution of both PL peaks. The analysis of the intensity vs voltage bias has been performed for the peak A of higher intensity. It was found that it decreases at a forward bias corresponding to the built-in voltage. This effect has been ascribed to the non-radiative recombination processes. The interpretation of the PL-V measurements has been given by means of the so called "dead layer" model [2] (cf. Fig. 2). Summarizing, the PL technique allowed for characterization of defects responsible for radiative recombination in the CdTe-based junctions.

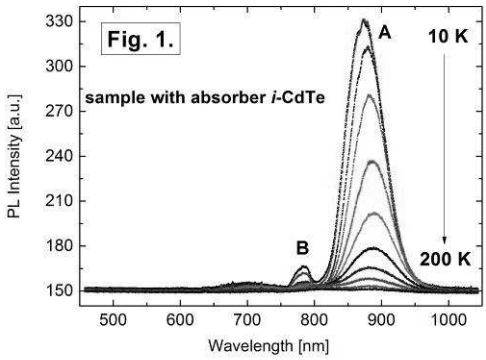

Fig. 1 PL spectra measured at different temperatures.

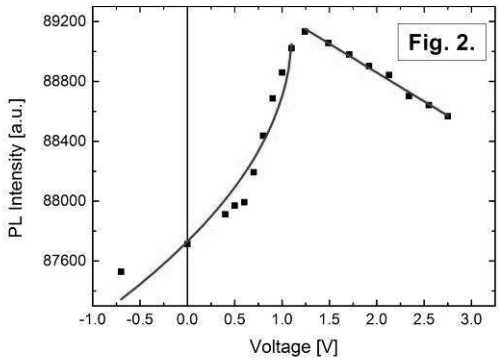

Fig. 2 PL intensity of peak A vs voltage bias. Solid lines – fitting to the experimental data, using the "dead layer" model.

[1] J. Lee, N. C. Giles, D. Rajavel, and C. J. Summers, *J. Appl. Phys.* **78**, 5669 (1995).
[2] D. Shvydka, V. G. Karpov, and A. D. Compaan, *Appl. Phys. Lett.* **80**, 3114 (2002).