# Photovoltaic effect damping by defect states in heterojunction

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The paper concerns study of extended states acting as recombination centers of minority carriers, located at the photovoltaic heterojunction region.

The photovoltaic heterojunction consists of two semiconductors with different crystalline and electronic band structures and different minority and majority carriers. The generation of the carriers leads to the remarkably higher increase of relative minority carrier density than that of the majority carriers. Because of this the change of quasi Fermi level energy value of majority carriers is negligible small in comparison to the change of minority carriers quasi Fermi level at the opposite sides of the junction. The differences of quasi Fermi level energy shifts on the opposite sides of heterojunction for the electrons and for the holes contribute to total open circuit voltage $V_{oc}$ of the heterojunction. In most cases the contribution of majority carriers can be neglected, while the minority carriers contribute to the created $V_{oc}$ value [1]. Thus the expected high value of $V_{oc}$ can be strongly reduced by recombination centers or traps of minority carriers.

The considered heterojunctions were based on ZnTe (p-type) and CdTe (n-type) semiconductors [2,3] and were grown by molecular beam epitaxy. The results of study by DLTS (Deep Level Transient Spectroscopy) [2,3] and illumination intensity spectra of $V_{oc}$ [1] were taken in account. In DLTS data a wide peak was observed for minority carriers (with the positive value of the filing pulse height [2]) in the middle of the CdTe valence band gap. The illumination intensity spectra of $V_{oc}$, (the scan of forbidden gap by quasi Fermi level energy versus illumination intensity) the four peaks in the region of about 70mV below the thermal equilibrium Fermi level energy. The energy position of the peaks obtained by illumination intensity spectra of $V_{oc}$ corresponds well to the main wide peak of the density of minority carriers states in DLTS spectra. The states correspond to the kind of extended states (e.g. dislocations, steps) and they are causing the effect of minority carriers recombination and reduction of $V_{oc}$ value with further increase of illumination intensity.

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