Assignment of anomalous DLTS signals to additional barriers in Cu(In,Ga)Se_2 solar cells

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CIGS thin-film solar cells are multiple-layer structures. DLTS is traditionally applied for studying carrier trapping by defects. Spectra recorded on thin-film devices are often interpreted in terms of defects in the absorber layer or at its interfaces. Recently, in the context of interpretation of the capacitance spectroscopy signals observed for CIGS solar cells, we studied the DLTS characteristics of a non-Ohmic contact in layered structures - acting as a junction polarized oppositely to the main junction - theoretically, on model devices and on actual solar cells. We found that such a contact may give rise to a strong DLTS signal that can readily be distinguished from that of defects by comparing DLTS results after regular and inverted electric pulses [1]. We also demonstrated that the signal of defects located either in a certain layer or at interfaces between layers cannot exhibit these properties [2]. It was shown that both the N1 and the N2 signals reported in literature for CIGS solar cells exhibit the behavior of contacts, rather than of defects in the layers [3].

The DLTS signals of non-ideal contacts may be very intense and hamper the intended detection of carrier trap levels inside the layer. Nonetheless, they may also provide valuable information on the thin-film device if they allow to extract the diode characteristics of the non-ideal contact. In this work we demonstrate that, via fitting the DLTS spectra with regular and inverted pulses of various heights, one can determine these parameters.

[1] Lauwaert et al. J. Appl. Phys 109, 063721 (2011)
[2] Lauwaert et al. Progress In Photovoltaics 20(5), 588-594 (2012)
[3] Lauwaert et al. Sol. Ener. Mater. Sol. Cells 112, 78-83 (2013)