Deep level transient spectroscopy (DLTS) study of P3HT:PCBM organic solar cells

Johan Lauwaert[1], Samira Khelifi[2], Lisanne Van Puyvelde[1], Koen Decock[2], Marc Burgelman[2], Donato Spoltore[3], Fortunato Piersimoni[3], Jean Manca[3] and Henk Vrielinck[1].

[1]*Department of Solid State Sciences, University of Gent, Krijgslaan 281-S1, B-9000 Gent, Belgium*
[2]*Department of Electronics and Information Systems (ELIS), University of Gent, Sint-Pietersnieuwstraat 41, B-9000 Gent, Belgium*
[3]*Institute of Materials Research, University of Hasselt, Wetenschapspark 1, B-3590 Diepenbeek, Belgium*

The electronic structure of an organic photovoltaic bulk heterojunction cell strongly deviates from the typical textbook examples of a single sided junction used to explain electrical characterization of defects in semiconductors. Therefore it is not so straightforward to assign the capacitance of this device or the charge in it to the presence of a depleted layer within this structure. However, conventional electronic spectroscopic techniques could give useful information to understand the electronic behaviour of the device. Therefore, in this work capacitance and charge DLTS have been performed on P3HT:PCBM solar cells.

To avoid this parasitic effects low frequency capacitance DLTS (20 kHz) has been performed, showing an anomalous signal with negative amplitude and a complementary positive signal could be observed altering the biases. Charge DLTS clearly revealed that both signals transients, conventional and with altered bias have the same time constants. A recent study has shown that such behaviour cannot be explained by the thermodynamic properties of capture and emission of carriers by a defect in bulk semiconductor. The validity of alternative explanations, including interface states, non-ideal ohmic contacts and effects of carrier hopping on charge mobility, will be discussed.