Reduced Langevin Recombination in Organic Solar Cells

Gytis Juška
Department of Solid State Electronics, Vilnius University, Lithuania
*e-mail : gytis.juska@ff.vu.lt

In the organic solar cells due to low charge carriers mobilities a bimolecular Langevin recombination is usually observed, which causes reduction of the energy conversion efficiency. Recently, the reduced Langevin recombination was observed in the high efficiency solar cells [1].

In this work we will discuss different models of the Langevin recombination's reduction: the influence of the random potential [2], the intrinsic electric field [3], the influence of the mobility of the slower charge carriers in the bulk heterostructures [4] and the morphology of the structure [5]. For the determination of the origin of the reduction we used three methods: the extraction of the photogenerated charge carriers by the linearly increasing voltage (photo-CELIV), the double injection current transients (DoI) and time of flight (TOF).

The experimental results of the reduced Langevin recombination in the regioregular poly(3-hexylthiophene) with [6,6]-phenyl-C61-butyric acid methyl ester (RRP3HT/PCBM) organic solar cells proof that this reduction is caused by two-dimensional Langevin recombination when the lamellar structure is formed [5]. In this case the relaxation of the density of the photogenerated charge carriers follows $n \sim t^{-2/3}$ and the bimolecular recombination coefficient depends on the density of the charge carriers $\beta \sim n^{1/2}$. The spacing between the lamellas evaluated from the experimental results is close to one determined from the X-ray studies.

References

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