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PHOTOVOLTAICS GROUP

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Our group participates in two photovoltaics projects of 6FP of EU, in the field of thin film PV, projects ATHLET and SE PowerFoil

The expertise of our group currently covers two main areas of research:

- optical and photoelectrical spectroscopy of thin films, PDS (Photothermal Deflection Spectroscopy) and FTPS (Fourier Transform Photocurrent Spectroscopy)
- optical design of thin film solar cells, single or multijunction

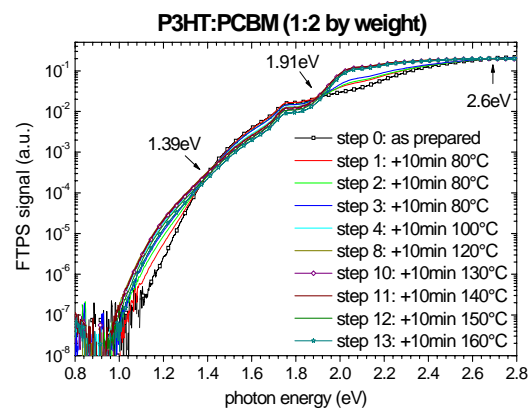
We are also currently beginning to prepare (spincoat) our own bulk heterojunction organic solar cells based on P3HT:ThCBM blend.

FTPS: The basic idea of the FTPS [1] is to use the measured sample (solar cell or just thin absorber layer) as an external detector of a Fourier transform infrared spectrometer with an external light beam output and thus obtain the photocurrent spectra, normalized by spectrally independent detector. FTPS is very sensitive, dynamic range obtained with this method reaches 7 orders of magnitude in organic solar cells. Typical spectral range of our measurements is 0.8 – 2.8 eV. In linear scale we measure quantum efficiency, in a log scale (look at Fig.) we “see” electronic transitions due to defects and disorder.

Optical modeling: The model CELL [2] was developed in our group with the goal to simulate the optical absorption and light trapping in thin film silicon solar cells. It is a Monte-Carlo model, based on the tracing of individual photons. It can cope with nanorough surfaces and this is readily used for the estimate of efficiency increase due to the light trapping. For amorphous/microcrystalline thin film solar cells the results of the model are in very good agreement with experiment. We modeled quantum efficiency spectra of organic solar cells with an active layer of MDMO-PPV:PCBM (1:4 by weight) and P3HT:PCBM (1:1 wt.) with a flat and a nanorough back reflector [3]. The results predicts up to 25% efficiency increase when a nanorough backreflector is used in P3HT:PCBM based cell (compared to a flat one), however this finding is yet to be experimentally confirmed.

Organic photovoltaics: We began to focus on the organic solar cells in the year 2004. In cooperation with the Institute for Materials Research (IMO-IMEC) of Hasselt University in Belgium, we measured the photocurrent spectra of MDMO-PPV:PCBM (1:4wt.) based cells [4].

FTPS study of the annealing of P3HT:PCBM: In the year 2006, during his stay at IMO, A. Purkrt prepared (under the supervision and with the help of L. Goris) a series of cells based on P3HT:PCBM mixture, with varying weight ratios of the constituents (55%, 66.66% and 75% wt. content of PCBM in the mixture). The cells were then subjected to step-wise thermal annealing in the range of 80-160°C, during which a various bias voltage was applied. FTPS spectra together with V-A characteristics were measured after each step. Changes induced by annealing depend heavily on the absorber composition. There are profound changes in the spectra for the 1:2 (66.66% wt. of PCBM) composition, whereas for 55% and 75% the changes are much smaller, if any. Moreover, we observed three isosbestic points in measured spectra of the 1:2 composition (66% PCBM) during annealing at lower temperatures (up to 140°C) at 1.39, 1.91, and 2.6eV [5].



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[3] A. Purkrt, J. Springer, A. Poruba, M. Vaněček, L. Goris, J. Manca: *Modelling the current density increase due to the "light-trapping" effect in conjugated polymer/fullerene-based bulk heterojunction solar cells*, Proc. of NUMOS - International Workshop on Numerical Modelling of Thin Film Solar Cells, Eds. M. Burgelman, M. Topič, Gent, Belgium, 28-30 March 2007, pp. 133-139, ISBN: 978-90-382-1109-1 - <http://www.elis.ugent.be/numos/program.html>

[4] L. Goris, A. Poruba, L. Hodakova, M. Vanecek, K. Haenen, M. Nesládek, P. Wagner, D. Vanderzande, L. De Schepper, J. Manca, *Observation of the subgap optical absorption in polymer-fullerene blend solar cells*, APL 88 (2006) 052113; DOI:10.1063/1.2171492.

[5] A. Purkrt, A. Poruba, M. Vanecek, L. Goris, J. Manca: *Photoelectric study of P3HT:PCBM solar cell annealing with varying composition of the active layer*, Proc. of 22nd EU PVSEC, Milan, Italy, (2007), pp. 487-490