

Organic Photovoltaic Devices with fine-controlled Morphology and Donor:Acceptor Composition

M. Rusu^a, S. Wiesner^a, D. Keiper^b, J. Gasiorowski^a,
N. Meyer^b, M. Heuken^b, K. Fostiropoulos^a, M.Ch. Lux-Steiner^{a,*}

^aDepartment SE2, Hahn-Meitner-Institut Berlin, Glienicker Strasse 100, 14109 Berlin, Germany

^bAIXTRON AG, Kackertstr. 15-17, 52072 Aachen, Germany

*Corresponding author: Phone/Fax: +49-30-8062-2462/3199, e-mail: lux-steiner@hmi.de

The most efficient molecular photovoltaic (PV) devices reported to date have been fabricated using a heterojunction based on a copper phthalocyanine (CuPc) donor (D) and a fullerene (C₆₀) acceptor (A) materials. The best results were achieved on device structures which contain a D/A interpenetrating folded morphology and D:A mixed layers. The devices were prepared by using the vacuum thermal evaporation (VTE), the investigations being performed on small area devices ~0.01 cm². However, preparation of thin-film organic devices on large area substrates, the control of layer morphology and mixing of multiple compounds into a single film, which are keys to the achievement of high device performance, are often difficult using the VTE method.

In this contribution, to overcome the limitations of the VTE technique, a new organic vapor-phase deposition (OVPD[®]) process is used for the preparation of organic molecular solar cells [1,2]. Devices based on mixed D:A layers as well as nanostructured CuPc films are investigated. The CuPc layers morphology is precisely tuned from a nanostructure with horizontal rods-like crystallites to columnar grown crystallites. Film characterization including scanning electron microscopy observations, X-ray diffraction and optical measurements are carried out. The basic properties of the devices are investigated on small area 0.05...0.4 cm² cells which show efficiencies as high as 1.7%. The results are discussed in terms of morphology of the mixed layers and formation of improved channels for charge transport. Additionally, large area 25 cm² organic solar cells are prepared. Monolithic PV mini-modules of areas ~21 cm² with an open circuit voltage of about 1.3 V are demonstrated.

[1] M. Rusu, S. Wiesner, T. Mete, H. Blei, N. Meyer, M. Heuken, M. Ch. Lux-Steiner, K. Fostiropoulos, Renewable Energy 33, 254 (2008).

[2] M. Rusu, J. Gasiorowski, S. Wiesner, N. Meyer, M. Heuken, K. Fostiropoulos, M. Ch. Lux-Steiner, Thin Solid Films (2007), doi: 10.1016/j.tsf.2007.12.004