INFLUENCE OF THE RELATIVE HUMIDITY ON THE PERFORMANCE OF POLYMER/TIO2 PHOTOVOLTAIC CELLS

L.H. SLOOFF, AND J. M. KROON

Energy research Center of the Netherlands (ECN), P.O. Box 1, 1755 ZG Petten, THE NETHERLANDS,
Dutch Polymer Institute (DPI), P.O. Box 902, 5600 AX, Eindhoven, THE NETHERLANDS.

J. LOOS

Laboratory of Polymer Technology, Eindhoven University of Technology, STO 0.41, P.O. Box 513, 5600 MB, Eindhoven, THE NETHERLANDS.
Dutch Polymer Institute (DPI), P.O. Box 902, 5600 AX, Eindhoven, THE NETHERLANDS

M.M. KOETSE

The Netherlands Organization for Applied Scientific Research (TNO), P.O. Box 6235, 5600 HE Eindhoven, THE NETHERLANDS.
Dutch Polymer Institute (DPI), P.O. Box 902, 5600 AX, Eindhoven, THE NETHERLANDS

Hydrolysis of titanium(IV)isopropoxide (TTIP) is a well-known method for the fabrication of TiO2. Normally it is made in a sol-gel reaction in the presence of water. In this paper we report on the preparation of TiO2 films for polymer/TiO2 photovoltaic cells, made from TTIP in isopropanol. It is shown that the morphological structure of the TiO2 film is strongly dependent on the relative humidity during spin coating. In bi-layer devices consisting of ITO/TiO2/ poly[2-methoxy-5-(3',7'-dimethyloctyl)-p-phenylene vinylene] (MDMO-PPV)/PEDOT/Au, a low relative humidity is needed to form smooth, transparent TiO2 films. Increasing the relative humidity results in porous TiO2 films with a high surface roughness, leading to pinholes and shunted devices. The TiO2 films in these devices were sintered at 450 oC for one hour. A maximum performance was obtained at a relative humidity of 5%. These devices showed an Voc of 490 mV, an Isc of 0.9 mA/cm2, a FF of 61 % and a maximum power point (MPP) of 0.29 mW/cm2 (measured at roughly 1 sun AM1.5)
Also bulk heterojunction (BHJ) ITO/PEDOT/(hybrid TiO2:MDMO-PPV blend)/LiF:Al photovoltaic cells have been made. The BHJ was made by spin coating a mixture of TTIP and MDMO-PPV in toluene. These devices have a reversed structure compared to the bi-layer devices. This makes sintering of the TiO2 not possible. Again a strong relation was found between the relative humidity during spin coating and the device performance. However, in contrast to the flat TiO2 films, the best BHJ devices were made at a higher relative humidity of about 50%. For these devices an Voc of 510 mV, an Isc of 0.74 mA/cm2 FF of 39% and a MPP of 0.14 mW/cm2 was measured. The observed performance dependence on relative humidity is discussed in relation to the device structure and TiO2 morphology as measured with SEM. These measurements show that it is very important that the devices are made in an atmosphere in which the relative humidity is well controlled.

TOPICS + KEYWORDS: Hybrid Polymer/Inorganic Solar Cells, Preparation conditions, bulk hetereo junction.