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Parameters limiting the lifetime of bulk heterojunction solar cells: a systematic study

F. Padinger[a] , P. Denk[a], C. J. Brabec[b] and N. S. Sariciftci[b]

[a] *Quantum Solar Energy Linz, Austria*

[b] *Linz Institute for Organic Solar Cells, Physical Chemistry, Johannes Kepler University of Linz, Austria*

Polymer photovoltaics offer great technological potential as a renewable, alternative source for electrical energy. The demand for inexpensive renewable energy sources is the driving force to new approaches in the production of low cost polymer photovoltaic devices. In the last couple of years, enhanced efforts have been put into the development of solar cells based on organic molecules and conjugated polymers.[1-8]

Thus far, the efficiency of polymer solar cells under AM1.5 illumination has been increased to >2.5 % [9], utilizing a soluble poly-(phenylene vinylene) derivative as hole conductor and a methanofullerene as electron conductor. Although 2.5 % is a very promising value for an all organic system, one of the deficiencies of these systems is the rather poor stability under atmospheric conditions. The utilization of all organic photovoltaic devices needs at least lifetimes in the order of several thousand working hours for an industrial application.

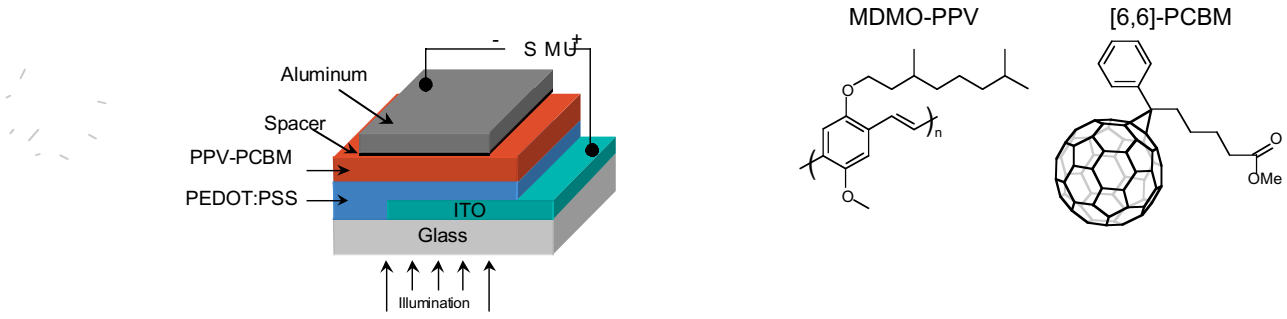

Fig.1: Device structure and chemical structure of MDMO-PPV and PCBM

To achieve this life time at least two problems have to be solved. Due to the influence of atmospheric environment (oxygen and/or moisture) on the MDMO-PPV a gas tight sealing technique of plastic solar cells is necessary. On the other hand the influence of electrical current , temperature and

light has to be investigated under inert gas atmosphere to exclude atmospheric influence for an understanding and consecutively a prevention of aging effects.

In our work we investigate the degradation behaviour of bulk heterojunction polymer / fullerene based photovoltaic devices under inert gas atmosphere on a 100 h time scale. To study changes in the behaviour of current-voltage (IV) - curves under electrical stressing as well as the temperature under illumination conditions we investigated the degradation process systematically under argon atmosphere. Furthermore different thermal treatments to single layers of plastic solar cells were performed during the production process and the top electrodes were exchanged to monitor their influence on the degradation.

AFM studies were made to detect the influence of the morphology on the efficiency as well as on the life time of plastic solar cells. The smoothness/roughness of the surface of the PEDOT:PSS film and of the PPV:PCBM film gives information on the proper choice of the solvent, temperature treatment and phase separation.

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