Recent sensible and senseless developments in molecular photovoltaics

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Introduction

Research on plastic solar cells, based on the molecular donor-acceptor bulk-heterojunction principle, has inspired many workers in the broad field of photovoltaics to investigate new concepts. Often, existing concepts are being mixed into new hybrid-like devices. Another common practice is to transfer knowledge obtained by others in related fields of research, e.g. on polymer light emitting diodes or on molecular field effect transistors, to the field of molecular photovoltaics. This 'post-modern' kind of research approach has led to a myriad of variations in design of PV devices. Although it is way too early to judge the possible eventual relevance of these new variations and concepts for the development of a holy grail type super PV device of the future, a critical discussion on some examples seems worthwhile in a careful attempt to determine whether they make sense or not. Some of these examples are:

The use of an exciton blocking layer

Recently, remarkable external power conversion efficiencies have been claimed for 'double-heterostructure' (i.e. layered donor-acceptor structure) molecular photovoltaic cells in which an 'exciton-blocking layer' (EBL) was incorporated.[1] The concept of an EBL in a molecular PV device structure will be discussed.

The use of sensitizing additives to bulk-heterojunction PV layers

Up to now, none of the molecular ingredients of bulk-heterojunction photovoltaic devices have had optimally narrow optical band-gaps. Hence, a very large portion of the AM1.5 spectrum is not absorbed by the devices. While the chemists are presently working on the development of new PV materials with a more appropriate band gap, others investigate the use of additives that are to function as sensitizer component, i.e. harvesting parts of the solar spectrum uncovered by the basic mixture.[2] The introduction of a third active component in a blend leads to a very complex set of possible interactions, however.

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[1] a. P. Peumans, V. Bulovíc, S.R. Forrest, "Efficient photon harvesting at high optical intensities in ultrathin organic double-heterostructure photovoltaic diodes", *Appl. Phys. Lett*. **76**, 2650 (2000); b. P. Peumans, S.R. Forrest, "Very-high-efficiency double-heterostructure copper phthalocyanine/C_{60} photovoltaic cells", *Appl. Phys. Lett*. **79**, 126 (2001).

[2] a. C.J. Brabec, S.E. Shaheen, T. Fromherz, F. Padinger, J.C. Hummelen, A. Dhanabalan, R.A.J. Janssen, N.S. Sariciftci, "Organic photovoltaic devices produced fromconjugated polymer / methanofullerene bulk heterojunctions", *Synth. Metals* **121**, 1517 (2001); b. C. Winder, G. Matt, J.C. Hummelen, R.A.J. Janssen, N.S. Sariciftci, C.J. Brabec, "Sensitation of low bandgap polymer bulk heterojunction solar cells", Presented at E-MRS 2001, Strasbourg, to be published in *Thin Solid Films*; c. C. Winder et al., contribution to this QUANTSOL 2002 conference.