Polymer-Based Organic Solar Cells: Tuning of Active Layer Nanomorphology and Enhancement of Photovoltaic Performance Using Alkoxy Side Groups

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Alkoxy side groups grafted on the backbone of semiconducting polymers act primarily as solubilising agents in order to render the materials processable into thin films for various optoelectronic applications. Beyond this primary function, alkoxy side chains strongly influence the supramolecular ordering of the polymers in solid state, which consequently has an impact on the thermal behavior and the physicochemical properties of such photoactive materials.[1-3]

Using poly(arylene-ethynylene)-*alt*-poly(arylene-vinylene)s, **PAE-PAV**s, a new class of conjugated materials combining the interesting intrinsic properties of both poly(arylene-ethynylene)s (**PAE**s) and poly(arylene-vinylene)s (**PAV**s), we were able to demonstrate that the hydrophobic nature of alkoxy side groups can be used to tune the solar cells active layer nanomorphology. The bulk heterojunction intermixing between donor (polymer) and acceptor (fullerene derivative) was shown to be significantly dependent on the side chains nature (linear and/or branched) and volume fraction. Systematic side chain fine tuning has led to an increase of the energy conversion efficiency, $\eta_{AM1.5,}$ from 0.3% to 5.0%, the latter value being the present state-of-the-art efficiency for **PAV** based materials.[4-7]

Keywords: Organic solar cells, alkoxy side chains, polymers, nanomorphology.

1. Egbe, D. A. M.; Carbonnier, B.; Birckner, E.; Grummt, U.-W. *Prog. Polym. Sci.* **2009***, 34,* 1023-1067
2. Egbe, D. A. M.; Neugebauer, H.; Sariciftci, N. S. *J. Mater. Chem.* **2011**, *21*, 1338 – 1349
3. Rathgeber, S.; Bastos de Toledo, D.; Birckner, E.; Hoppe, H.; Egbe, D. A. M. *Macromolecules* **2010**, *43*, 306-315.
4. Egbe, D. A. M.; Türk, S.; Rathgeber, S.; Kühnlenz, F.; Jadhav, R.; Wild, A.; Birckner, E.; Adam, G.; Pivrikas, A.; Cimrova, V.; Knör, G.; Sariciftci, N. S.; Hoppe, H. *Macromolecules* **2010***, 43*, 1261-1269.
5. Egbe, D. A. M.; Adam, G.; Pivrikas, A.; Ramil, A. M.; Birckner, E.; Cimrova, V.; Hoppe, H.; Sariciftci, N. S. *J. Mater. Chem.* **2010**, *20*, 9726-9734.
6. Susarova, D. K.; Khakina, E. A.; Troshin, P. A.; Goryachev, A. E.; Sariciftci, N. S.; Razumov, V.; Egbe, D. A. M, *J. Mater. Chem.* **2011**, *21,* 2356-2361
7. Adam, G.; Pivrikas, A.; Ramil, A. M.; Tadesse, S.; Yohannes, T.; Sariciftci, N. S.; Egbe, D. A. M., *J. Mater. Chem.* **2011**, *21*, 2594 – 2600.