POLYMERIC MATERIALS AS PHOTOVOLTAIC MATERIAL FOR SOLAR CELLS

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INTRODUCTION.

By using approach of designing copolymers with donor-acceptor alternating units, with solubilising groups and without hindering desired planarity, it is possible to obtain effective low band-gap organic semiconducting materials. Recently, research group [1-5] have put a lot of effort to develop polymeric materials fulfilling such requirements. According to computational study, copolymer keeping the same chemical architecture [3] but replacing benzothiadiazole with pyridinothiadiazole (PTD) as central unit may have lower band-gap due to the higher electron affinity of PTD unit.

RESULTS AND DISCUSSION.

Investigation revealed that alkyl chains in beta-position (fourth position of thiophene rings) lead to better pi-electron delocalisation due to enchanced planarity, because such position avoids rotational hinderance. Also, ramified alkyl side chains were found to be more appropriate for giving the compound better solubility. Additionally, change from linear alkyl chain to ethylhexyl branched solubilising side chain affected interaction between fullerene and polymer in bulk heterojunction devices. Synthesis of PPTDT^2-CEHβ copolymer based on this chemical structure was performed and its physical and optoelectronical properties were studied as well.

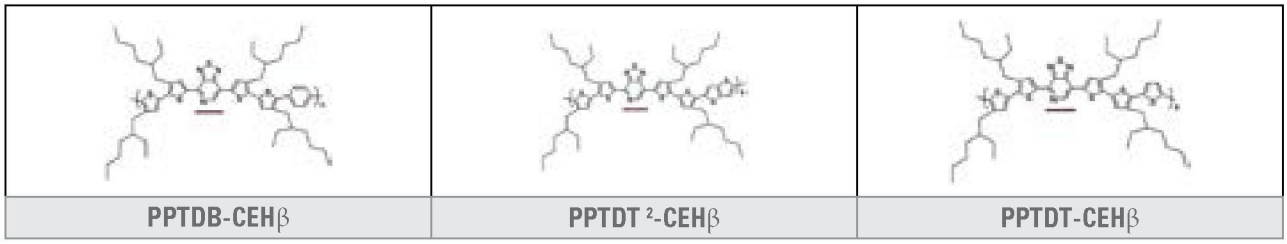

Figure 1. *Polymer (P) formed by the alternation of a trimer (T) derived from a central 2,1,3-benzothiadiazole (Bz) or pyridinothiadiazole (PTD) unit surrounded by two alkylthiophene units, and a thieno[3,2-b]thiophene (T2) unit. The acronym extension highlights the side-chain nature and positioning: C8, C12, and CEH correspond to octyl, dodecyl, and 2-ethylhexyl alkyl chains respectively, whereas the indexes designate chains that are either in the third position (α) or the fourth position (β).*

CONCLUSIONS.

Synthesis of PPTD-benzole-CEHβ and PPTD-thiophene-CEHβ will be peformed and further PV-tests of copolymers will be carried out.

Table 1. Properties of previously studied and newly synthesised polymers (- theoretical data).*

Property	PPTDB-CEHβ	PPTDT2-CEHβ	PPTDT-CEHβ (new)
PCE	To be studied	4.3% (preliminary results)	To be studied
Band-gap	≈ 1.9 eV*	1.45 eV (preliminary results)	≈ 1.4 eV*
Solubility	Good in common solvents*	Good in common solvents	Good in common solvents*
Obtained MW	To be studied	Mn = 28kg/mol, PDI = 3	To be studied

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REFERENCES.

1. L. Biniek, C.L. Chochos, N. Leclerc, G. Hadziioannou, J.K. Kallitsis, R. Bechara, P.Lévêque, T.Heiser. (2009). A [3,2-b]thienotiophene-alt-benzothiadiazole copolymer for photovoltaic applications: design, synthesis, material characterization and device performances. J. Mater. Chem., 19: 4946–4951.
2. L. Biniek, C.L. Chochos, G. Hadziioannou, N. Leclerc, P. Lévêque, T. Heiser. (2010). electronic properties and photovoltaic performances of a series of oligothiophene copolymers incorporating both thieno[3,2- b]thiophene and 2,1,3-benzothiadiazole moieties. Macromol. Rapid Commun., 31(7): 651-656.
3. L. Biniek, S. Fall, C.L. Chochos, N. Leclerc, P. Lévêque, T. Heiser. (2012). Optimization of the side-chain density to improve the charge transport and photovoltaic performances of a low band gap copolymer. Organic Electronics, 13: 114–120.
4. L. Biniek, S. Fall, C.L. Chochos, D.V. Anokhin, D.A. Ivanov, N. Leclerc, P. Lévêque, T. Heiser. (2010). Impact of the alkyl side chains on the optoelectronic properties of a series of photovoltaic low-band-gap copolymers. Macromolecules, 43: 9779–9786.
5. L. Biniek, C.L. Chochos, N. Leclerc, O. Boyron, S. Fall, P. Lévêque, T. Heiser. (2012). 3,6-Dialkylthieno[3,2-b]thiophene moiety as a soluble and electron donating unit preserving the coplanarity of photovoltaic low band gap copolymers. J. Polym. Sci. Part A: Polymer Chemistry, 50: 1861–1868.