**Design and Synthesis of Semiconducting Macromolecules for Organic Electronics**

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In recent decades, organic electronics have attracted tremendous attention due to some recognized advantages compared with the inorganic counterparts, including low production cost, light weight, mechanical flexibility and large-area manufacturing with roll-to-roll method. The corresponding devices cover organic field-effect transistors (OFETs), organic photovoltaics (OPVs), perovskite solar cells (PSCs), organic light emitting diodes (OLEDs), sensors, logic circuits and more. The greatest merit of organic semiconductor (OSC) is their solution processability and tunable optoelectronic properties via rational molecular design. Some promising building blocks being used to construct OSCs for high performance electronic devices are generally found to meet the following criteria: i) conjugated backbone that is the basis of OSCs; ii) easy alkylation to make them soluble in common organic solvents; iii) multiple active reaction points to allow wide chemical modification for tuning the optoelectronic properties; iv) accessible coupling reaction to afford target small molecular or polymeric semiconductors. Some exemplary building blocks, such as diketopyrrolopyrrole (DPP), (3E,7E)-3,7-bis(2-oxoindolin-3-ylidene)benzo[1,2-b:4,5-b′]difuran- 2,6(3H,7H)-dione (BIBDF), anthanthrene (ANT) respectively. The potentials of anthanthrene chromophore-based materials in organic electronics were exploited by synthesizing four polymers and they were successfully applied in four different electronic devices. A power conversion efficiency (PCE) of 5.21% was achieved in OPVs whereas a record efficiency of 24% (stabilised efficiency of 23.7%) was obtained in dopant-free PSCs when ANT based polymers were used as the hole transport material. A simple yet effective approach to switch the charge carrier polarity in OFETs by varying the electron affinity of flanking groups of DPP units has been also studied. I will present range of macromolecules and their performance in various organic electronic devices in order to evaluate structure-property relationship study.

**References**

1. P. Sonar, J. Chang, Z. Shi, E. Gann, J. Li, J. Wu, C. R. McNeill, Hole mobility of 3.56 cm2 V−1 s−1 accomplished using more extended dithienothiophene with furan flanked diketopyrrolopyrrole polymer. J. Mater. Chem. C, 3, 9299 (2015)
2. T. T. Do, B. B. Patil, S. P. Singh, S. D. Yambem, K. Feron, Kostya (Ken) Ostrikov, J. M. Bell, P. Sonar, Vinylene and benzo[c][1,2,5]thiadiazole: effect of the π-spacer unit on the properties of bis(2-oxoindolin-3-ylidene)-benzodifuran-dione containing polymers for n-channel organic field-effect transistors. RSC Adv., 8, 38919 (2018)
3. B. Wang, T. P. Huynh, W. Wu, N. Hayek, T. T. Do, J. C. Cancilla, J. S. Torrecilla, M. M. Nahid, J. M Colwell, Oz. M. Gazit, S. R. Puniredd, C. R. McNeill, P. Sonar, H. Haick, A Highly Sensitive Diketopyrrolopyrrole‐Based Ambipolar Transistor for Selective Detection and Discrimination of Xylene Isomers. Advanced Materials 28, 4012 (2016).
4. Q. Liu, Y. Wang, A. Kohara, H. Matsumoto, S. Manzhos, K. Feron, S. E. Bottle, J. Bell, T. Michinobu, P. Sonar, Tuning the Charge Carrier Polarity of Organic Transistors by Varying the Electron Affinity of the Flanked Units in Diketopyrrolopyrrole-Based Copolymers, Advanced Functional Material, submitted.
5. Q. Liu, S. M. Jain, Y. Wang, L. Arunagiri, M. Khatib, S. Manzhos, K. Feron, Z.-K. Wang, J. R. Durrant, H. M. Upadhaya, S. E. Bottle, J. Bell, H. Haick, H. Yan, T. Michinobu, P. Sonar, Anthanthrene Based Semiconducting Polymers for Various Electronic Devices with Record Performance of 24% in Dopant-free Perovskite Solar Cells as Hole Transport Material. Joule, submitted.