Low band gap $(X\text{-}DADAD)_n$ type copolymers for stable and efficient bulk heterojunction organic solar cells

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Organic solar cells based on conjugated polymers demonstrated high power conversion efficiencies approaching 8-10%. Unfortunately, the most efficient electron donor materials undergo rapid photochemical degradation which dramatically affects the operational stability of the devices. On the contrary, long operation lifetimes have been predicted for some less efficient conjugated polymers possessing very robust chemical structures. In particular, a lifetime exceeding 20 years was estimated for solar cells based on [70]PCBM/PCDTBT blends.

In the present talk we will present our strategy of designing PCDTBT-like polymers with narrowed band gaps using alternating DADAD architectures as building blocks (D – electron donor unit such as thiophene, cyclopentadithiophene and etc., while A is an acceptor like benzothiadiazole or benzoxadiazole) [1-3]. The synthesized polymers demonstrated diverse optoelectronic and photovoltaic characteristics. The best materials showed solar cell power conversion efficiencies approaching 7% in combination with long-term operation stability. Higher performances of 10-11% are feasible for single junction devices based on the designed materials due their optimal band gaps (1.60-1.65 eV) and deep-lying HOMO energy levels (~ -5.5 eV).

The designed polymer-based materials enabled fabrication of larger area solar cells under ambient conditions in air using slot die coating which is a roll-to-roll compatible film deposition technology (performed in collaboration with Prof. S. Choulis, Cyprus University of Technology). The power conversion efficiency of the coated devices exceeded 6% which corresponds to the highest performances achieved in the field.

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[3] A V. Akkuratov, P. A. Troshin et. al., *J. Mater. Chem. C*, **2015**, 3, 1497