A new donor material for all-small-molecule organic solar cells with efficiency approaching 11%

With the support by the National Natural Science Foundation of China and the Ministry of Science and Technology of China, the research team led by Prof. Zhang HaoLi (张浩力) at the State Key Laboratory of Applied Organic Chemistry, Key Laboratory of Special Function Materials and Structure Design, College of Chemistry and Chemical Engineering, Lanzhou University, developed a new design strategy for donor material toward high-performance all-small-molecule organic solar cells, which was published in *Chemistry of Materials* (2018, 30: 8661—8668).

Design of the high-performance small molecule donor for all-small-molecule organic solar cells (ASM-OSCs) requires a combinative effort of optimizing the material design and device fabrication. Herein, a new dual-accepting-unit medium bandgap small molecule donor named SBDT-BDD is developed, which consists of a benzodithiophene (BDT) as the central electron donating unit in combination with two rhodanine (A_1) and two benzo-[1,2-c:4,5-c′[dithiophene-4,8-dione (BDD) (A_2) as the electron accepting units, forming a unique A_1-A_2-D-A_2-A_1 structure. The dual accepting units endow the SBDT-BDD with the complementary absorption and appropriate energy level with non-fullerene acceptor IDIC. Further investigations suggest that SBDT-BDD is morphologically compatible with the two acceptors of $PC_{71}BM$ and IDIC, benefitting formation of ideal film morphology and efficient exciton dissociation as well as suppressed charge recombination in devices, resulting in an outstanding current density and fill factor. The film-depth-dependent optical and electronic properties in such small molecule devices are synergistically optimized, to simultaneously manipulate photon harvesting contours and charge transport. The ASM-OSCs based on SBDT-BDD: IDIC blend produce a PCE of 9.2%, while the SBDT-BDD: IDIC: $PC_{71}BM$ ternary devices exhibit a significantly increased PCE of 10.9%. Upon molecule design to optimize morphology for precise manipulation of film-depth-and wavelength-dependent optical and electronic properties, this work provides a new strategy for small molecule donor towards high-performance ASM-OSCs.

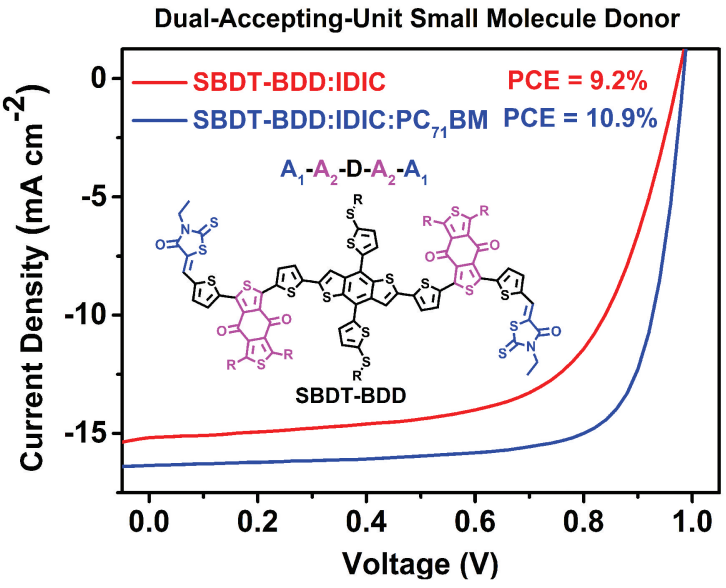

Figure The chemical structure of small molecule donor SBDT-BDD and *J-V* curves of binary and ternary devices.