Highly Planar Fluorinated Benzothiadiazole-Based Conjugated Polymer for High-Performance Organic Thin-Film Transistors

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Development of high-performance conjugated polymers is of primary importance for the fabrication of organic-based devices - such as organic thin film transistors (OTFTs), organic photovoltaics, organic memories, and sensors - on flexible plastic substrates at low temperature by cost-effective graphic art printing processes. However, organic electronic devices remain on the verge of commercialization due to long-term stability in real-life operations. Herein, we report the design and synthesis of high-performance and stable donor-acceptor (D-A) type polymer semiconductor; difluorobenzothiadiazole-dithienosilole conjugated polymer (PDFDT) as active material for organic thin-film transistors (OTFTs). High mobility and low-voltage operated (Fig. 1.) OTFTs are demonstrated with PDFDT conjugated polymer with fluorinated high-k polymer dielectrics. A record-breaking high hole mobility of 9.0 $cm^2V^{-1}s^{-1}$ for benzothiadiazole-based semiconducting polymer is achieved by excellent planarity of the semiconducting polymer. In addition, PDFDT-based OTFT devices showed good resistance to degradation under continuously stressed condition in electrically because of the lower highest occupied molecular orbital energy level of PDFDT polymer resulting from the incorporated fluorine atoms in backbone of conjugated polymer.

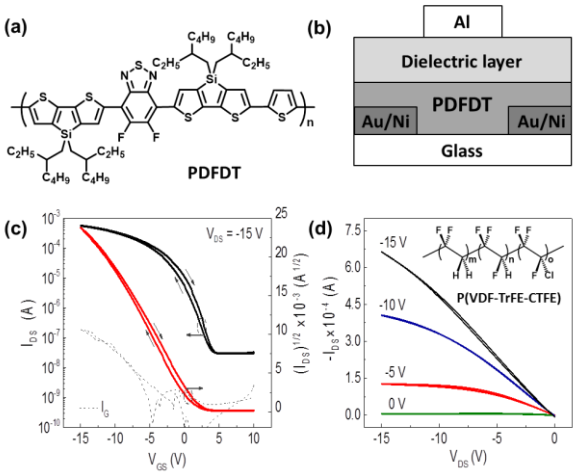

Fig. 1. (a) Chemical structure of PDFDT polymer, (b) top gate/bottom contact (TG/BC) OTFT device structure. The output and transfer characteristics of PDFDT-OTFTs with poly(vinylidenefluoride-trifluoroethylene-chlorotrifluoroethylene) (P(VDF-TrFE-CTFE) as gate dielectric are shown in (c) and (d) respectively.

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