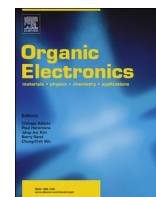




Contents lists available at ScienceDirect

Organic Electronics

journal homepage: <http://www.elsevier.com/locate/orgel>

Solution-processable fluorene derivative for organic thin-film transistors

Dongkyu Kim^{a,1}, M. Rajeshkumar Reddy^{b,1}, Kwanghee Cho^a, Dongil Ho^a, Choongik Kim^{a,*}, SungYong Seo^{b,**}^a Department of Chemical and Biomolecular Engineering, Sogang University, Seoul, 04107, Republic of Korea^b Department of Chemistry, Pukyong National University, Busan, 48513, Republic of Korea

ARTICLE INFO

Keywords:

Fluorene

Organic semiconductor

Organic thin-film transistors

Donor-acceptor-donor

Solution-process

ABSTRACT

New fluorene derivatives with donor-acceptor-donor (D-A-D) structure were synthesized and characterized as solution-processable organic semiconductors for top-contact/bottom-gate organic thin-film transistors (OTFTs). Physicochemical properties of the new compounds were characterized by cyclic voltammetry (CV), UV-vis absorption spectroscopy, thermogravimetric analysis (TGA), differential scanning calorimeter (DSC), and density functional theory (DFT) calculation. All compounds were TFT active and compounds with strong electron withdrawing groups showed ambipolar semiconductor performance with electron mobility of up to $0.1 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ and current on/off ratio of $> 10^6$.

1. Introduction

In recent years, development of low-cost, large-area organic electronic devices has been underway in various applications such as organic thin-film transistors (OTFTs), organic light-emitting diodes (OLEDs), and organic photovoltaics (OPVs) [1–9]. Especially, the design and synthesis of π -conjugated polymeric or small molecular organic semiconductors is driving the development of new organic electronic devices [10–16]. Of these, small molecular organic semiconductors have gained much interest since they can be synthesized relatively easily and purified at a high purity with excellent reproducibility [17–24].

In recent semiconductor studies, organic semiconducting materials containing both electron-accepting (acceptor) and electron-donating (donor) moieties in their molecular structure have been studied extensively because of their high electrical performance [25–31]. Tuning the highest occupied/lowest unoccupied molecular orbital (HOMO/LUMO) energy to improve the charge transport of both holes and electrons through the π -conjugated backbone can be easily accomplished by designing appropriate donor-acceptor structures [32–35]. Among many acceptor moieties, fluorene moieties have been studied extensively due to their air stability with strong solid state interactions [36–38]. For donor structure, thiophenes are commonly employed since they exhibit sufficiently low ionization potentials to ensure ohmic contact to holes [39].

In this regard, we have synthesized four new organic semiconductors with donor-acceptor-donor (D-A-D) structure comprising fluorene derivative and thiophenes as electron-accepting and electron-donating moieties, respectively (Fig. 1). Furthermore, terminal alkyl chains (ethyl hexyl or octyl) were employed to ensure the solution-processability of the corresponding compounds in common organic solvents. Thermal, optical, and electrochemical properties of all new compounds were confirmed by thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), UV-vis spectroscopy, and cyclic voltammetry (CV). The synthesized molecules were tested as solution-processed organic semiconductors for top-contact/bottom-gate OTFTs. The resulting device showed electron mobility as high as $0.1 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ and current on/off ratio of $> 10^6$.

2. Experiment details

2.1. General methods

Air and/or moisture sensitive reactions were carried out under an argon atmosphere in oven-dried glassware and with anhydrous solvents. Unless otherwise noted, all compounds were purchased from commercial sources and used without further purification. Tributyl(5-(2-ethylhexyl)thiophen-2-yl)stannane (7a) [40], tributyl(5-(octylthiophen-2-yl)stannane (7b) [40], and 2,7-diiodo-9H-fluoren-9-one [41] were

* Corresponding author.

** Corresponding author.

E-mail addresses: choongik@sogang.ac.kr (C. Kim), syseo@pknu.ac.kr (S. Seo).¹ These authors contributed equally to this work.