Lateral Electron Collection Using High-Mobility PTCDI-C8 for the Application of Organic Solar Cells

1. IMS, 2. Mahidol Univ., 3. Toyohashi Univ. of Tech., 4. Osaka Perf. Univ. 5. NEDO

°Thidarat Kunawong[1,2], Mitsuru Kikuchi[1,5], Masaki Hirota[1,5], Yusuke Shinmura[1,5], Hiroyoshi Naito[4,5], Aya Myint Moh[3,5], Masanobu Izaki[3,5], Masahiro Hiramoto[1,5]

E-mail: thidarat@ims.ac.jp

Introduction The comb-type electrodes have not been used to operate organic solar cells because they need the carrier transport of lateral direction. Previously, we demonstrated a successful operation for lateral electron collecting organic solar cell using NTCDA single crystal[1]. In this work, we adopted PTCDI-C8 having high electron mobility (1.7 cm^2/Vs)[2] compared with that of NTCDA (10^{-2} cm^2/Vs)[1] to increase the electron transport length, L_e (= μτE).

Experimental Cells (Fig. 1) were fabricated by thermal evaporation on quartz or sapphire substrates. Length of electrons moving in lateral direction (red arrow) is 1,000 times longer than that of holes moving in vertical direction (blue arrow) for L = 50 μm.

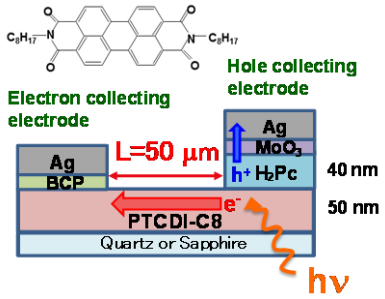

Fig. 1 Lateral electron collecting cell

Results and Discussion Though small photocurrent was generated for lateral electron collecting cells fabricated on quartz (blue curve), photocurrent density significantly increased when sapphire was used as substrate (red curve) (Fig. 2). PTCDI-C8 films deposited on sapphire were single crystalline whereas those deposited on quartz was polycrystalline having vast number of grain boundaries that limited electron transport. The maximum mobility of PTCDI-C8 film reported so far (1.7 cm^2/Vs) was two order higher than that measured mobility of polycrystalline PTCDI-C8 film (FET mobility = 10^{-2} cm^2/Vs). Based on the equation: $L_e = \mu\tau E$, for polycrystalline PTCDI-C8 film, photocurrent disappeared because electron transport range ($L_{e\,(cal)}$ = 17 μm) is shorter than lateral electrode distance (50 μm). In contrast, electron transport range of single crystalline PTCDI-C8 film ($L_{e\,(cal)}$ = 1.7 mm) is larger than lateral electrode distance (50 μm) so that photocurrent appeared. Now, we are determining electron transport range (L_e) by varying the distance between lateral electrodes (L).

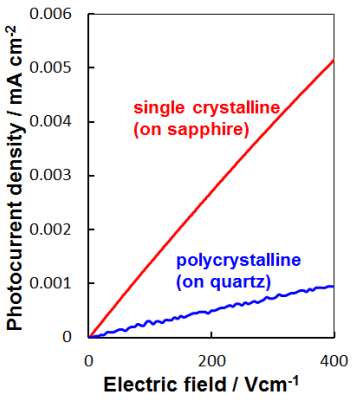

Fig. 2 Photocurrent-electric field characteristics for single crystalline (red curve) and polycrystalline PTCDI-C8 (blue curve).

1) Kikuchi, M. et al. The 76th autumn meeting. JSAP 15p-2N-7 (2015).

2) Chesterfield, R. J. et al. *J. Phys. Chem. B*, **108**, 19281 (2004).