Photovoltaic Behavior of Centimeter-Long Lateral Organic Junctions

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Recently, we reported a lateral alternating multilayered junction using a high mobility organic semiconductor[1)]. In this study, we fabricated lateral junction cells having distance reaching cm order (Fig. 1). A donor [C8-BTBT (μ_h = 43 cm^{2}V^{-1}s^{-1})] – acceptor [PTCDI-C8 (μ_e = 1.7 cm^{2}V^{-1}s^{-1})] combination was used. Buffer layers of BCP and MoO_3 were used for the selective carrier collection of electrons and holes, respectively (Fig. 1). Surprisingly, even lateral cells with L=1.8 cm showed clear photovoltaic behavior (Fig. 2, red curve). Fig. 3 shows the L dependence of observed J_{sc} (red curve) and calculated J_{sc} (blue curve) obtained from diffusion lengths of electrons (4.7 mm) and holes (5.5 mm), which are dominated by traps. These diffusion lengths were obtained by the experiments using the moving photomask covering the irradiated surface from respective electrodes. Thus, considerable decrease in photocurrent is attributed to the trap-assisted recombination indicated by the blue curve. A further difference between the observed and calculated curves is due to bimolecular recombination and its effect is small. Thus, we concluded that trap-assisted recombination can be the main reason for photocurrent loss of the long lateral cells. Hence, identifying and removing the defects acting as traps can be done to improve cell performance.

1) M. Kikuchi, et al, *ACS Appl. Energy Mater.*, **2**, 2087-2093 (2019).

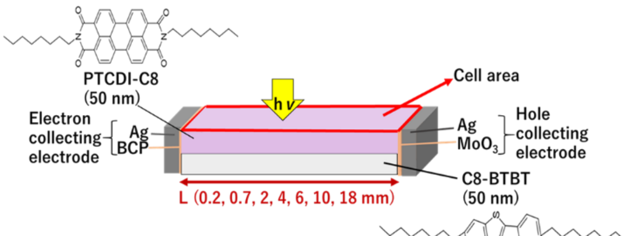

Fig. 1 Structure of a lateral junction cell.

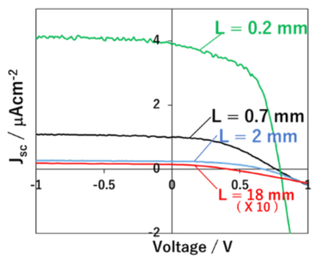

Fig. 2 J_{sc}–V curve of cells with L = 0.2, 0.7, 2, and 18 mm.

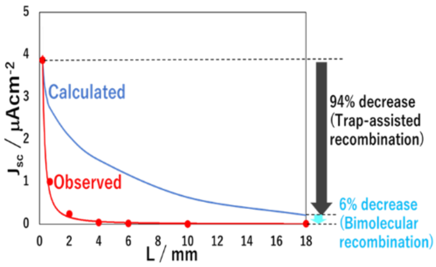

Fig.3 Dependence of J_{sc} on L.