

Effects of Solvent Mixtures on Nanoscale Phase Separation and Photovoltaic Efficiency of Mesogenic - Phthalocyanine - Based Bulk Heterojunction Solar Cell

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はじめに： A mesogenic phthalocyanine derivative, 1,4,8,11,15,18,22,25-octahexylphthalocyanine (C6PcH₂) has been demonstrated as a promising small molecule for use in bulk heterojunction (BHJ) solar cells.^[1] C6PcH₂ exhibits not only excellent processability for thin films but also appropriate electronic characteristics for a solar cell, such as a deep highest occupied molecular orbital energy level, a relatively small band gap, strong optical absorption, and high hole and electron drift mobilities exceeding 1.4 cm²V⁻¹s⁻¹ and 0.5 cm²V⁻¹s⁻¹ in the crystalline phase, respectively. Despite their prominent characteristics, solar cells, in which the active layer was composed of C6PcH₂ and a fullerene derivative, 1-(3-methoxy-carbonyl)-propyl-1-1-phenyl-(6,6)C61 (PCBM), showed relatively low power conversion efficiency (PCE).^[2] Herein, we report the high performance of C6PcH₂:PCBM BHJ solar cells fabricated with separated phases using solvents mixtures.

実験： MoO_x films were thermally evaporated onto ITO substrates. A solution containing a mixture of C6PcH₂:PCBM (2:1) in toluene with 1,8-diiodooctane (DIO), was spin-cast onto a MoO_x layer. Finally, a LiF buffer layer and an aluminum layer were deposited through a shadow mask by thermal evaporation.

結果： As shown in Fig. 1, the C6PcH₂:PCBM devices without DIO in toluene showed a PCE of 3.1%, with a short-circuit current density (J_{sc}) of 7.4 mA/cm², an open-circuit voltage (V_{oc}) of 0.83 V, and a fill factor (FF) of 0.50. By using DIO to control the nanomorphology, the performance of BHJ solar cells was markedly improved. As depicted in Fig. 2, by adding 0.2% v/v DIO to toluene, the external quantum efficiency was improved from 48% to 54% at the Q-band and the shoulder of the B-band emerged at 450 nm and the PCE increased to 3.7% with a J_{sc} of 8.7 mA/cm² and a FF of 0.55. Further, by incorporating 0.2% v/v of 1,8-dibromooctane to chloroform, the J_{sc} and the PCE increased to 9.7 mA/cm² and 4.2%, respectively.

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[1] Y. Miyake *et al.*, *Appl. Phys. Express*, **4** (2011) 021604. [2] Q.D. Dao *et al.*, *Jpn. J. Appl. Phys.*, **52** (2013) 012301

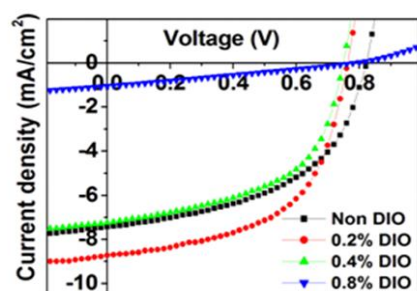


Fig. 1 Dependence of J-V characteristics of the cells on amount of DIO

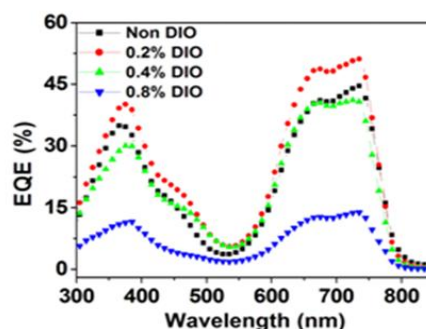


Fig. 2 Dependence of EQE of the cells on amount of DIO