Area: 4 Organic and Dye-Sensitized Solar Cells

µM-THICK VACUUM DEPOSITED PTHALOCYANINE :C_{60} PHOTOVOLTAIC CELLS UTILIZING CO-EVAPORANT INDUCED CRYSTALLIZATION

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Organic photovoltaic cells (OPVs) have achieved performance suitable for practical applications. Since optical absorption is essential for photocurrent, the thickness of the active layer is designed to take advantage of the standing wave. Here we show that that both the short-circuit current and the efficiency of OPV cells can be enhanced with increasing the thickness of the active layer beyond what is commonly needed for optical optimization such as for the third standing wave. We have found µm-thick film can be used for vacuum deposited donor:acceptor blend layers based on pthalocyanine :C_{60}.

For the deposition of µm-thick pthalocyanine:C_{60} blend layers, we used a unique method of "co-evaporant induced crystallization", which enabled crystallization and growth control of molecular films during vacuum evaporation. In this method, a liquid molecule was introduced as a co-evaporant during evaporation. Its function was to induce crystallization of the deposited films, but it was removed from the deposited film simultaneously by maintaining the substrate at a suitable temperature during deposition. Fig. 1 shows the results of thickness-dependent properties of ZnPc:C_{60} OPVs where the active layer thickness is over a range of 40 nm–10 µm, as an example. Without crystallization (i.e. without co-evaporant), *J*sc decreases dramatically to less than 1 mA/cm^2 as the blend ZnPc:C_{60} layer becomes thicker than 40 nm. With crystallization (i.e. with co-evaporant), *J*sc is significantly higher and increases with increasing active layer thickness, leveling at about 18 mA/cm^2 from 500 nm to 1000 nm. From 2 µm to 10 µm, the J_{sc} still retains a high value, leveling around 16 mA/cm^2. This remarkable result suggests a pathway for further improvements of the efficiency of OPV cells. Additionally, we will show the effects of crystallization of the active layer, the use of various interface layers on achieving reproducibly high short-circuit current of 16–21 mA/cm^2 in these extraordinary thick OPV cells, and the results on other phtalocyanines:C_{60} blend layers.

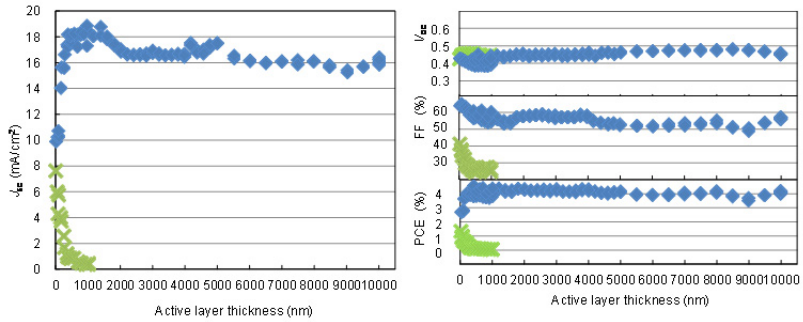

Figure. 1 Thickness-dependent properties of ZnPc:C_{60} OPVs in 40 nm–10µm range of thickness.