

## Organic photovoltaic cells using low sheet resistance of ITO for large-area applications

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Organic photovoltaic (OPV) cells have attracted considerable attention due to their potential for flexible, lightweight, and low-cost application of solar energy conversion. Since a 1% power conversion efficiency (PCE) OPV based on a single donor-acceptor heterojunction was reported by Tang, the PCE has steadily improved around 5%. It is well known that a high parallel (shunt) resistance and a low series resistance are required simultaneously to achieve ideal photovoltaic devices. The device should be free of leakage current through the device to maximize the parallel resistance. The series resistance is attributed to the ohmic loss in the whole device, which includes the bulk resistance and the contact resistance. The bulk resistance originated from the bulk resistance of the organic layer and the electrodes; the contact resistance comes from the interface between the electrodes and the active layer.

Furthermore, it has been reported that the bulk resistance of the indium tin oxide (ITO) of the devices dominates the series resistance of OPVs for a large area more than  $0.01 \text{ cm}^2$ . Therefore, in practical application, the large area of ITO may significantly reduce the device performance. In this work, we investigated the effect of sheet resistance ( $R_{sh}$ ) of deposited ITO on the performance of OPVs. It was found that the device performance of polythiophene-fullerene (P3HT:PCBM) bulk heterojunction OPVs was critically dependent on  $R_{sh}$  of the ITO electrode. With decreasing  $R_{sh}$  of the ITO from 39 to  $8.5 \Omega/\square$ , the fill factor (FF) of OPVs was dramatically improved from 0.407 to 0.580, resulting in improvement of PCE from  $1.63 \pm 0.2$  to  $2.5 \pm 0.1$  % under an AM1.5 simulated solar intensity of  $100 \text{ mW/cm}^2$ .

**Keywords:** Organic photovoltaic (OPV), ITO electrode

## 자발적 상분리법과 수열합성법을 이용한 ZnO계 일차원 나노구조의 수직 합성법 연구

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From 10 years ago, the development of nano-devices endeavored to achieve reconstruction of information technology (IT) and nano technology (NT) industry. Among the many materials for the IT and NT industry, zinc oxide (ZnO) is a very promising candidate material for the research of nano-device development. Nano-structures of ZnO-based materials were grown easily via various methods and it attracts huge attention because of their superior electrical and optical properties for optoelectronic devices. Recently, among the various growth methods, MOCVD has attracted considerable attention because it is a suitable process with benefits such as large area growth, vertical alignment, and accurate doping for nano-device fabrication. However, ZnO based nanowires grown by MOCVD process were had the principal problems of 1st interfacial layers between substrate and nanowire, 2nd a broad diameter (about 100 nm), and 3rd high density, and 4th critical evaporation temperature of Zinc precursors. In particular, the growth of high performance nanowire for high efficiency nano-devices must be formed at high temperature growth, but zinc precursors were evaporated at high temperature. These problems should be repaired for materialization of ultra high performance quantum devices with quantum effect. For this reason, we firstly proposed the growth method of vertical aligned slim MgZnO nanowires ( $< 10 \text{ nm}$ ) without interfacial layers using self-phase separation by introduced Mg at critical evaporation temperature of Zinc precursors ( $500 \text{ }^\circ\text{C}$ ). Here, the self-phase separation was reported that MgO-rich and the ZnO-rich phases were spontaneously formed by additionally introduced Mg precursors. In the growth of nanowires, the nanowires were only grown on the wurzite single crystal seeds as ZnO-rich phases with relatively low Mg composition ( $\sim 36 \text{ at } \%$ ). In this study, we investigated the microstructural behaviors of self-phase separation with increasing the Mg fluxes in the growth of MZO NWs, in order to secure drastic control engineering of density, diameter, and shape of nanowires.

**Keywords:** hydrothermal, ZnO nanorods, MOCVD, MgO NWs