Semi-Transparent Organic Solar Cells Based on Free-Standing Carbon Nanotube Top Electrodes prepared with Damage-Free Processing

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Among numerous advantages of organic photovoltaic cells such as low-cost, flexibility, and suitability for roll-to-roll mass production, an unusual and promising property is the possible semi-transparency of devices. Semi-transparent organic photovoltaic cells (STOPVs) allow the installation of solar cells on windows or other architectural building elements by providing artistically colored and tinted light, shadow, and at the same time electricity. The fabrication of efficient transparent conductive electrodes for both top and bottom contact is of great importance for STOPVs. Metal oxides, conducting polymers, silver nanowires, and thin metal layers have been employed as a top electrode for STOPVs and organic light emitting diodes. However, avoiding damage to underlying organic layers during the deposition of top electrodes are technological issues which are still challenging.

Here, we present small-molecule STOPVs based on ZnPc : C60 bulk heterojunction with free-standing carbon nanotubes (f-CNT) top electrodes prepared by an orthogonal liquid solution assisted self-laminating process. The STOPVs show very low leakage currents and high fill factors despite the rough f-CNT top electrodes. This indicates that the f-CNT lamination process can successfully avoid the damage of underlying organic layers. The device stack is systematically optimized with respect to the optical spacer effect, supported by optical simulations. The results indicate that STOPVs based on f-CNT top electrodes are highly promising for STOPVs with simple, cheap, and damage-free processing.

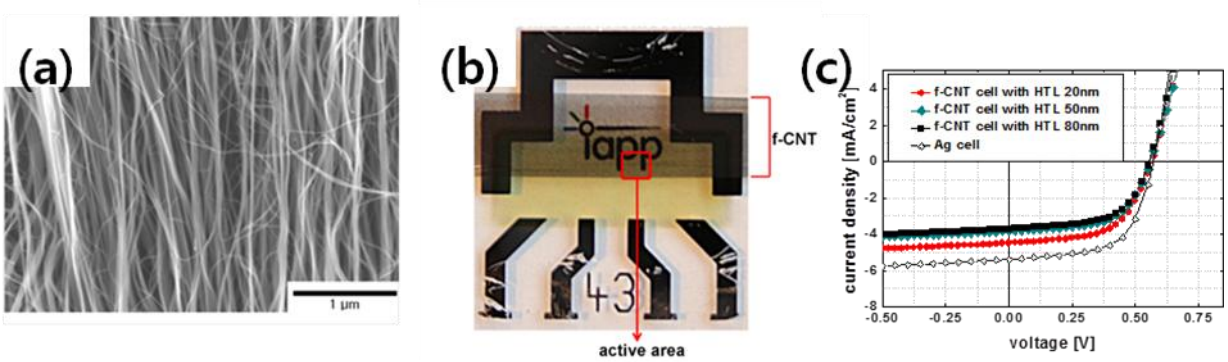

Fig. 1. (a) Scanning electron microscope images of f-CNT electrodes, (b) a photograph of STOPVs with f-CNT top electrodes, and (c) IV curves for STOPVs based on f-CNT and thin Ag top electrodes.

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References

1. Y. H. Kim, L. Müller-Meskamp, A. A. Zakhidov, C. Sachse, J. Meiss, J. Bikova, A. Cook, A. A. Zakhidov, and K. Leo, Solar Energy Materials & Solar Cells 96, 244 (2012)
2. Y. H. Kim, C. Sachse, A. A. Zakhidov, J. Meiss, A. A. Zakhidov, L. Müller-Meskamp, and K. Leo, Organic Electronics 13, 2422 (2012)