Full roll-to-roll fabrication process of large-area flexible OLED with silver-nanowire transparent electrode

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1. Introduction

The organic light emitting diodes (OLEDs) have attracted great interest owing to their high efficiency, design flexibility and environmental friendly in the lighting and display industry. However, for the general lighting and signage applications, cost of the OLED panel is still too high compared to another lighting source like a fluorescent lamp or inorganic LED. To lower the fabrication cost of OLED panels, not only the materials but also the fabrication process should be changed. Compare to conventional batch process, the roll-to-roll process has advantages like low fabrication cost, fast process time. In order to accomplish all fabrication process in roll-to-roll type, we adopted silver-nanowire embedded flexible transparent electrode on a PET substrate as an anode for OLED. For encapsulation, a moisture-barrier layer composed of Al_2O_3 and polymer layers were deposited with the roll-to-roll equipment. Finally, phosphorescent blue OLEDs were deposited with the roll-to-roll thermal evaporator.

2. Experiment

First, Silver-nanowires were coated on the polyimide (PI) donor film using a Meyer rod installed in the roll-to-roll coater. Silver-nanowire dispersed solution (0.5 wt% in IPA) was continuously supplied behind the Meyer rod while the PI donor film kept passing through underneath the Meyer rod. Right after coating, the solvent evaporated with dryer and finally, the silver-nanowire network was formed on PI donor film. Second, UV-curable embedding layer was blade coated on top of the silver-nanowire network and thermally annealed to remove the impurities in the UV-curable embedding layer which affect the lifetime of OLED. And moisture barrier layer composed of Al_2O_3 and polymer layers were deposited on top of it. Third, optical epoxy coated PET acceptor film was laminated. After thermal curing, due to the surface energy difference between PI donor film and PET acceptor film, the silver-nanowire embedded layer was transferred to PET acceptor film. Finally, the insulator was printed on top of the fabricated silver-nanowire embedded electrode for patterning [1]. With the fabricated electrode, OLEDs were deposited via the roll-to-roll thermal evaporator. After the OLED deposition SUS foil was laminated with desiccant dispersed adhesive for top-side encapsulation.

3. Results

The specular transmittance of the fabricated electrode was 85% at 550nm with 8 Ω/sq sheet resistance. The surface roughness of the fabricated electrode was very smooth owing to the embedding process (RMS: 3nm). With a screen printer, we printed various pattern of insulator on top of the fabricated electrode. And the efficiency of OLED fabricated by the roll-to-roll process was almost same as the conventional batch process. We also fabricated large-area OLED signage by the fully roll-to-roll process. Due to the size limitation of screen-printer, the maximum size of one pattern was 300mm x 150mm. with a series of screen-printing process, we fabricated 1 m long and 150 mm wide large-area OLED signage

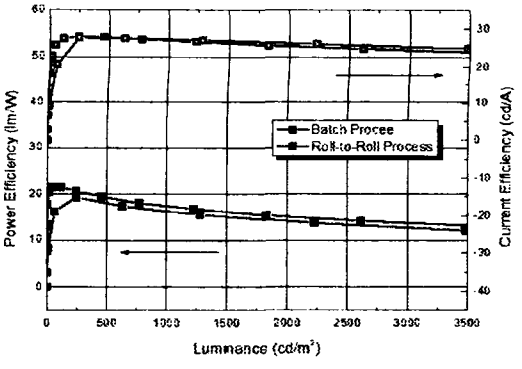

Figure 1: Efficiency of the fabricated OLED

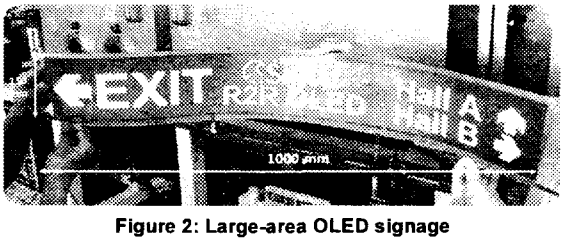

Figure 2: Large-area OLED signage

4. Conclusion

We fabricated large-area OLED panels with the full roll-to-roll process from the silver-nanowire embedded flexible transparent electrode to hybrid moisture barrier film. The performance of the fabricated OLED was comparable to batch processed OLED. With the roll-to-roll process, we expect much short process time and low process cost.

5. References

[1] E. Jung, C. Kim, M. Kim, H. Chae, J. H. Cho, S. M. Cho, "Roll-to-roll preparation of silver-nanowire transparent electrode and its application to large-area organic light-emitting diodes," Org. Electron., Vol. 41, pp.190-197 (2017)