Manufacturing of Organic Light Emitting Display by Polymer Inkjet Printing

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Abstract

The characteristics of polymer inkjet printing were investigated systematically in this paper. PEDOT/PSS as a hole injection layer and MEH-PPV as a light emitting layer were used for inkjet printing experiment. Inkjet head controlling technology and surface modification technology were also applied for polymer inkjet printing. With the developed polymer inkjet printing technology, OLED(Organic Light Emitting Display) was successfully fabricated and demonstrated.

1. Introduction

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In this paper, inkjet printing technology was used as the main patterning method for the OLED(Organic Light Emitting Display) fabrication. Basically, the OLED fabrication process requires two important techniques: high resolution printing and multi-layer printing [1]. In order to achieve high resolution printing, stable jetting is one of the essential factors. Concerned with control of inkjet driving signal, however, general strategy to optimize jetting stability has not been understood well, because of the inherent complex multi-physics nature in inkjet phenomena [2]. Motivated by this, present study investigates the effect of driving waveforms of piezoelectric head on jetting characteristics of DOD inkjet system focused on jetting stability for polymer inks such as PEDOT/PSS, MEH-PPV inks. With the developed polymer inkjet printing technology, OLED was successfully fabricated and demonstrated.

2. Experimental

Figure 1 showed the OLED manufacturing process used in this study.

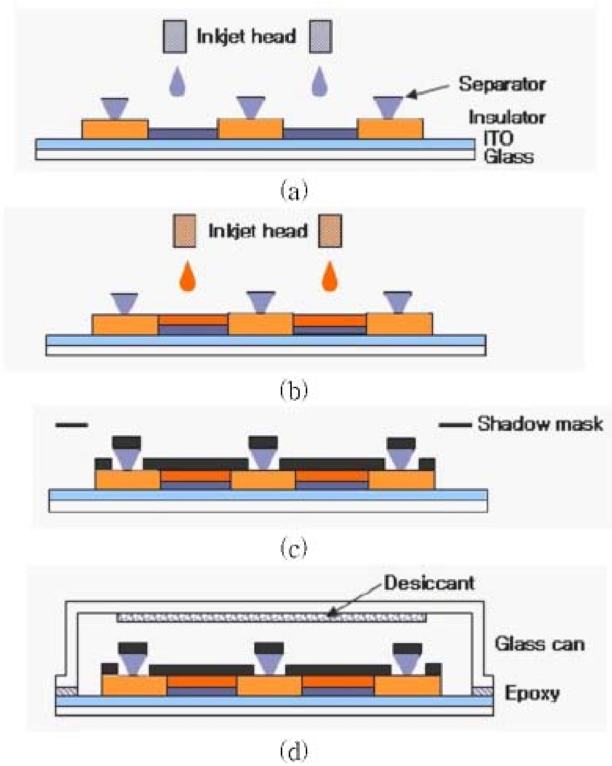

Fig. 1. Manufacturing process: (a) PEDOT:PSS inkjet printing; (b) MEH-PPV inkjet printing; (c) LiF/Al electrode deposition; (d) packaging.

The substrate was coated with Indium tin oxide (ITO) about 180 nm thicknesses. It was cleaned for 5 minutes in acetone and another 5 minutes in isopropyl alcohol (IPA) using an ultrasonic bath before printing.

The detailed description to prepare OLED and PEDOT:PSS was shown in the previous study[3].

The inks spreading and wetting of the ink on the substrate was controlled by the surface energy of substrate and the temperature of printing table which was also described in the previous study [3].

Table 1 showed the measured rheological property on of the polymer inks which were important to determine ink jetting characteristics.

Table 1 Rheological property on of the polymer inks used in this study

	Composition	Viscosity (cP)	Density (g/ml)	Surface tension (dyne/cm)
Hole injection layer	PEDOT/PSS +Glycerol +DI water (8:1:1 vol%)	9.4	1.0	79
Emitting light layer	MEH-PPV +NMP (1 w%)	5.7	1.0	35

Piezoelectric drop-on-demand inkjet heads from Dimatix were employed in this study. The inkjet printing tool included a cartridge type inkjet head with motorized x-y stage, a fiducial camera for the substrate alignment and drop watcher camera to control the drop shape. The exit diameter of the nozzle was 19um and the corresponding droplet volume was about 10 pl.

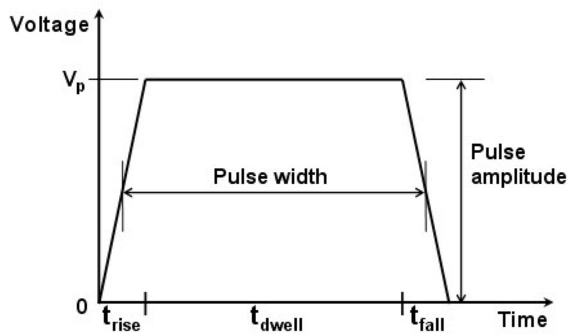

Fig. 2. Driving waveforms of piezoelectric head.

Figure 2 showed the shape of driving waveforms of piezoelectric head on jetting characteristics of DOD inkjet system. Pulse width and pulse amplitude were main controlling parameters for jetting experiments.

3. Results and discussion

Figure 3 showed the measured Jetting map at 21°C ambient temperature condition. The printed result of MEH-PPV ink was shown in Fig.4. Only "Single droplet" conditions were useful for making OLED devices because of its repeatable and straight ink droplet trajectory. With “Satellite” condition, a droplet divided into one major droplet and one satellite droplet which made printed patterns uncontrollable.

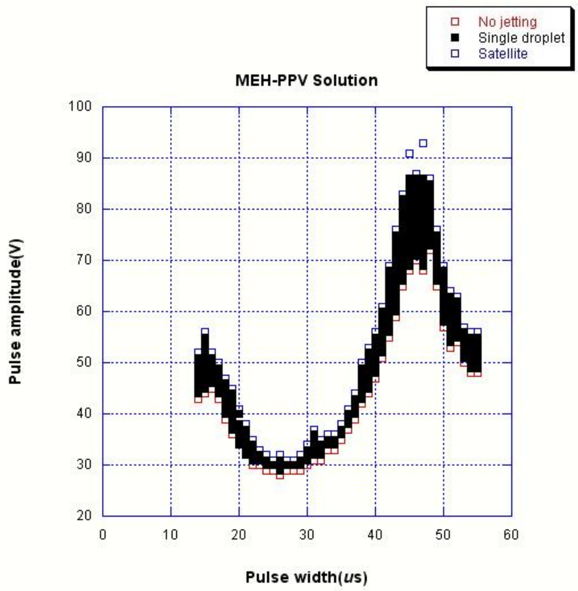

Fig. 3. Jetting map of MEH-PPV solution.

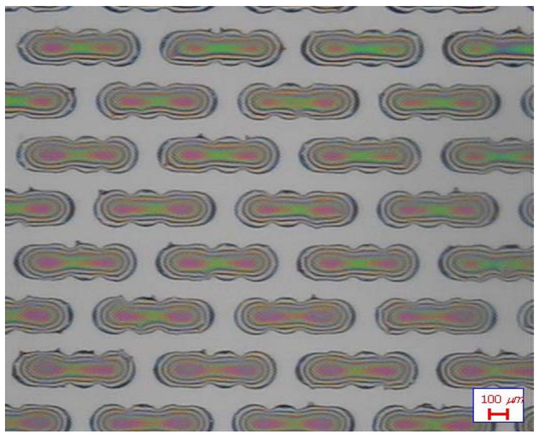

Fig. 4. Printed result of MEH-PPV solution.

Similar jetting map experiments were also conducted in order to make the jetting map of PEDOT/PSS ink. With proper surface energy controlled technology [3], PEDOT/PSS ink could be printed inside ITO patterned glass with PI banks shown in figure 5.

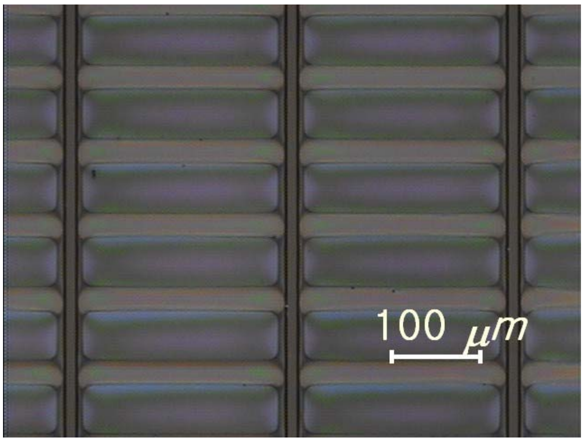

Fig. 5. Printed PEDOT/PSS onto PLED pattern.

In order to make a 1 inch PLED device, printed MEH-PPV over PEDOT/PSS layer as a active layer, the vacuum deposited LiF and Al as cathode layer and epoxy and a glass can as sealing are used. Figure 6 showed a manufactured 1-inch OLED device.

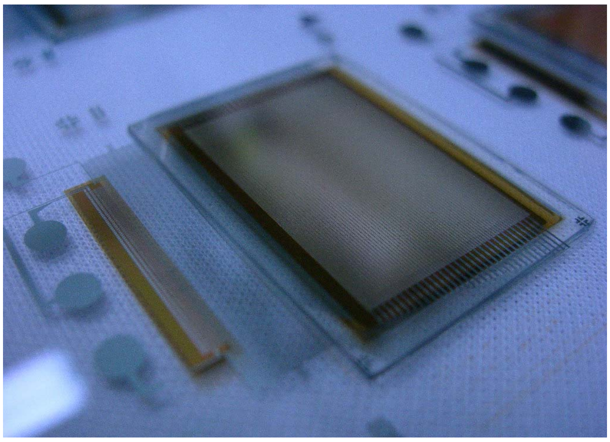

Fig. 6. 1 inch PLED.

4. Summary

Inkjet printing technology has been considered as the major patterning method for the organic electronics such as OLED. Most of the researches focus on development of proper organic materials with jetting capability. More studies for understanding of inherent complex multi-physics nature in inkjet phenomena with new polymer inks are also needed to be understood to achieve all inkjet printed electronics. This study can be a basic step to understand inkjet phenomena with polymer inks such as MEH-PPV and PEDOT/PSS inks.

Acknowledgement

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5. References

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