Substrate 온도에 따른 Ink-Jet Printed OTFT의 특성 변화

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Effect of Substrate Temperature on Electrical Properties of Ink-Jet Printed OTFTs

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Abstract - In this report, the effect of substrate temperature on the electrical properties of ink-jet printed triisopropylsilyl (TIPS) pentacene organic thin-film transistors (OTFTs) has been investigated. The electrical properties such as mobility and on/off ratio were decreased as the substrate was heated above room temperature. The field-effect mobility of decreased from 10^{-2} cm^2/Vs to 10^{-5} cm^2/Vs and the on/off ratio decreased from 10^6 to 10^4 when the substrate temperature was heated from room temperature to 60℃.

1. Introduction

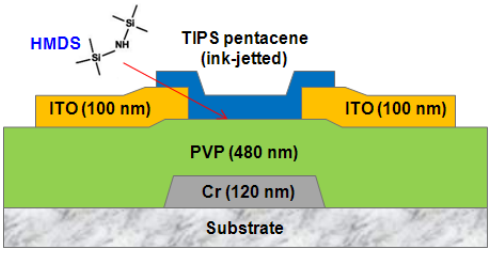
Organic thin-film transistors (OTFTs) based on polymers and small molecules have attracted a considerable attention in flexible electronics such as displays, photo sensors, pressure sensors and disposable radio-frequency identification tags (RF-IDs) due to their potential advantages of low-cost manufacturing, simple device architecture and compatibility to plastic substrates.[1,2] Most of the current researches on OTFTs are focused on realization of high-performance electrical switching devices as to integrate in flexible display panels such as liquid crystal displays, organic light-emitting diodes and electronic papers.[3]

The focus of this work is to investigate the substrate temperature effect on the electrical properties of ink-jet printed triisopropylsilyl (TIPS) pentacene OTFTs. As the substrate temperature increased from room temperature to 60℃, the field-effect mobility decreased from 10^{-2} cm^2/Vs to 10^{-5} cm^2/Vs and the on/off ratio decreased from 10^6 to 10^4.

2. Results and Discussion

2.1 Fabrication

The OTFTs were fabricated as described in Fig. 1. The transistor consists of Cr as gate electrode, poly-4-vinylphenol as gate insulator and indium-tin-oxide (ITO) as source/drain electrode. Before printing TIPS pentacene layer, hexamethyldisiloxane (HMDS) was spin coated to improve the interface properties between PVP and TIPS pentacene. As a channel layer, TIPS pentacene (a p-type semiconductor) form by ink-jet printing method using a Micorfab ink-jet head (Fig. 1). During the ink-jet printing process, the substrate was heated with temperature from RT, 40℃ and 60℃.

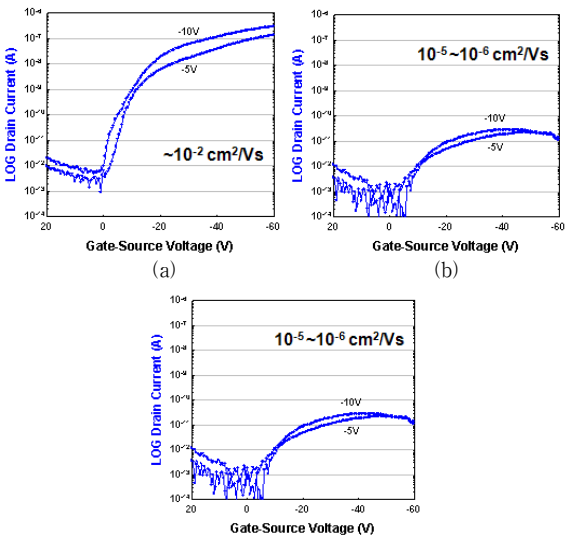


<Figure 1> Device structure of a fabricated organic thin-film transistor.

2.2 Results

The transfer characteristics of ink-jet printed OTFTs fabricated with different substrate temperature are displayed in Fig. 2. It is clear that the on-state current is significantly decreased as the substrate temperature increases. As a result, the field-effect mobility decreased from 10^{-2} cm^2/Vs to 10^{-5} cm^2/Vs and also, the on/off ratio of the transistor decreased from 10^6 to 10^4.

It is known that the crystallinity of an organic semiconductor layer affects the electrical properties of an OTFT. When the substrate is heated during the ink-jet printing process, the evaporation rate of TIPS pentacene drop becomes much faster. Because of this fast evaporation rate, there is not enough time for TIPS pentacene to crystallize and as a result, the crystallinity is poor.



<Figure 2> Transfer curves of OTFT with different substrate temperature applied during ink-jet printing, (a) RT, (b) 40℃, (c) 60℃.

3. Conclusion

In this report, the effect of substrate temperature on the electrical properties of ink-jet printed TIPS pentacene OTFTs has been investigated. The electrical properties such as mobility and on/off ratio were decreased as the substrate was heated above room temperature.

[References]

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[3] J. B. Chang et. al., J. Appl. Phys. 100, 014506 (2006).