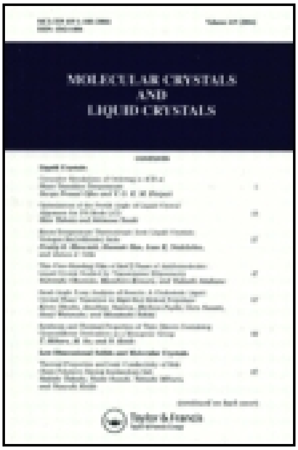


Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl19

Application of Organic Materials to Electronic Devices with respect to Thin Film Transistor and Sensor

Chung-Kun Song [a], Bon-Won Koo [a] & Min-Kyung Jung [a]

[a] School of Electrical and Electronics and Computer Engineering, Dong-A University, 840 Hadan-dong Saha-gu, Pusan, 604-714, Korea

Version of record first published: 24 Sep 2006

Mol. Cryst. and Liq. Cryst., 2001, Vol. 370, pp. 337-342

Application of Organic Materials to Electronic Devices with respect to Thin Film Transistor and Sensor

CHUNG-KUN SONG, BON-WON KOO and MIN-KYUNG JUNG

School of Electrical and Electronics and Computer Engineering Dong-A University 840 Hadan-dong Saha-gu, Pusan, 604-714, Korea

In this paper the applications of organic materials to thin film transistor (TFT) and sensor are presented. The organic TFTs using pentacene were fabricated and analyzed the performance. CO gas sensor using a new type dendrimer containing ferrocene as a functional group produced good performance to detect CO gas.

Keywords: OTFT, Gas sensor, Dendrimer, Pentacene

INTRODUCTION

Currently the application of organic semiconductors is mostly concentrated on the organic EL devices which are attracted as the next generation of light emitting devices, and partly on organic thin film transistor (OTFT) as the active device driving EL device.[1]-[3]

The organic gas sensors surpass the solid-state sensors in terms of selectivity to a specific gas and linearity and operating temperature.

In this paper with the results of fabrication of OTFT using pentacene as the active layer and CO gas sensor based on a new type dendrimer containing ferrocene we presents the application of organic materials to electronic devices.

Organic Thin Film Transistor: OTFT

In this paper we fabricated OTFT using pentacene as the active layer. We deposited the pentacene with OMBD (Organic Molecular Beam Deposition) system. The deposition conditions of the substrate temperature (from 30°C to 80°C by 10°C) and the deposition rate (5Å /sec and 0.3Å/sec) were varied to determine the optimum condition. The conductivity of pentacene thin film was measured and depicted in Fig.1.

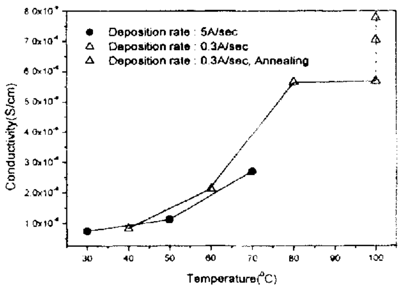
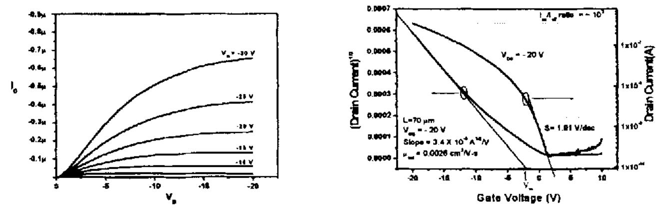


FIGURE 1. The conductivity of pentacene thin film

The conductivity for both small and large deposition rate was increased with the temperature while the slope becomes larger for the small deposition rate. The maximum conductivity of 6×10^{-6} S/cm was obtained at T=80°C / R=0.3Å/sec, above which it saturates due to the possible re-evaporation from the substrate at the higher temperature. The annealing at 100 °C for 1 hr enhances the conductivity up to about 30%. Finally the optimum deposition condition was found to be the substrate temperature of T=80°C and the deposition rate of R=0.3Å /sec. With the various channel length of 10μm, 25 μm, 50 μm, and 70 μm OTFTS were fabricated.

The pentacene OTFT exhibited the typical characteristics of p-type TFT and the performance parameters were extracted from the transfer characteristics in Fig.2 and summarized in Table 1.



(a) characteristics of p-type TFT (b) the transfer characteristics

FIGURE 2. (a) the characteristics of p-type TFT (b) the transfer characteristics of p-type TFT

TABLE 1. The performance parameters of OTFT

OTFTs		Parameters					
		μ_{FET} (cm^2/Vs)	I_{on}/I_{off}	V_T (V)	SS V/dec	Off-state current(A)	g_m(S)
Channel Length (μm)	10	0.00063	10^4	-2.57	1.10	~10^{-10}	1.84×10^{-8}
	25	0.0017	10^4	-2.83	1.68	~10^{-10}	2.76×10^{-8}
	50	0.0021	10^4	-3.03	1.09	~10^{-10}	1.85×10^{-8}
	75	0.0026	10^3	-3.78	1.91	2×10^{-10}	2.08×10^{-8}

As the channel length increases from10 μm to 70 μm, the mobility also increases from 6.3×10^{-4} $cm^2/V.sec$ to 2.6×10^{-3} $cm^2/V.sec$. The on/off current ratio was about 10^4 and the threshold voltage was 3±0.5V, and the sub-threshold slope 1.5±05V/dec which is relatively high, and the trans-conductance 10^{-8}S.

Organic Gas Sensor

A new type dendrimer, which was used in this experiment, contains ferrocene as a functional group for good selectivity to CO gas and illustrated in Fig.3.

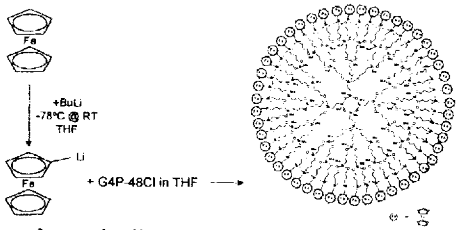
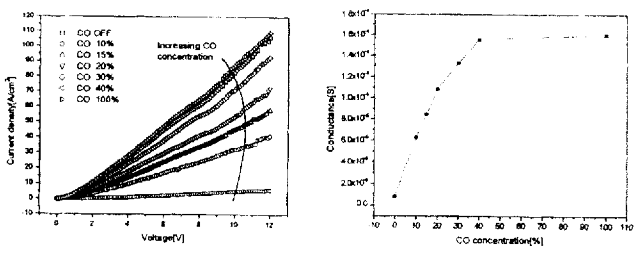


FIGURE 3. The schematic diagram of the systhesized dendrimer(G4-48 ferrocene). The molecular weight of pure dendrimer was ca.18600 dalton.

In order to understand the remarkable effects of CO gas sensing, the current variation was measured with respect to the various CO gas concentration as shown in Fig.4(a).



(a) (b)

FIGURE 4. (a) The current-voltage characteristics of dendrimer gas sensor for the various CO gas concentration (b) The conductance variation of dendrimer sensor according to the various CO concentration

The current was proportionally increased with the concentration. The conductance was varied by 10 times as the concentration increased up to 40% above which it saturated as shown in Fig.4(b).

Thus the dendrimer sensor was found to be very sentive to CO gas. Especially the concentration of CO gas can be quantitatively detected since the conductance is linearly varied with the concentration. This property increases the applicability of dendrimer sensor. A typical transient response of dendrimer sensor is shown in Fig.5.

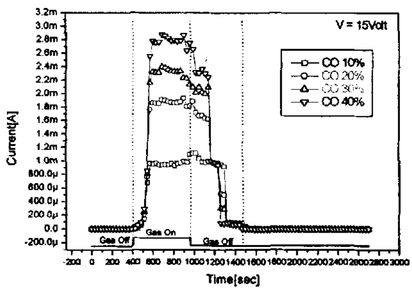


FIGURE 5. The transient response of dendrimer CO gas sensor at room temperature

The rising time which elapsed to rise from 10% to 90% of the steady state current level was 150 sec and the falling time was 420sec.

Conclusion

In this paper we presented two examples of organic materials application to electronic devices; OTFT and sensor. OTFT using pentacene thin film as the active layer exhibited the field effect mobility of 2.6×10^{-3} $cm^2/V.sec$.

A CO gas sensor based on siloxane dendrimer was fabricated and found to be very sensitive and selective to CO gas. The sensor produced a high conductance variation with CO concentration. It linearly increased by 10 times up to 40% volume concentration of CO gas.

Acknowledgement

This work has been supported by 21C Frontier Research Program of the Ministry of Science and Technology in Korea.

References

[1] Zhenan Bao, *Adv. Mater.* **3** (2000) 12-15

[2]H.Klauk, D. J. Gundlach, M. Bonse, C. C Kuo and T. N. Jackson, *Aappl. Phys. Lett.,* **76** (2000) 1692.

[3]Christos D. Dimitrakopoulos, Bruce K. Furman, Graham, Suryanarayan Hegde and Sampath Purushothaman, *Synthetic Metals*, **92** (1998) 47-52