

F16CuPc를 이용한 Field Effect Transistor의 전기적 특성 연구

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Electrical Properties of Field Effect Transistor using F16CuPc

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Abstract : We fabricated organic field-effect transistors (OFETs) based a fluorinated copper phthalocyanine (F₁₆CuPc) as an active layer. And we observed the surface morphology of the F₁₆CuPc thin film. The F₁₆CuPc thin film thickness was 40nm, and the channel length was 50 μ m, channel width was 3mm. We observed the typical current-voltage (I-V) characteristics and capacitance-voltage (C-V) in F₁₆CuPc FET and we calculated the effective mobility.

Key Words : Fluorinated copper phthalocyanine(F₁₆CuPc), Organic Field-effect transistor(OFET), Effective mobility

1. Introduction

Organic field effect transistors (OFETs) are very attractive for low-cost and low performance applications devices, such as Organic light-emitting diode (OLED) and integrated circuit for organic circuits [1]. It has been known phthalocyanine derivate materials with high thermal and chemical stability represent one of the most promoting candidates for modern optical electronic devices such as optical recording, gas sensors, thin film transistors and solar cells [2, 3]. The F₁₆CuPc material has a similar molecular shape and a similar crystal structure, with a hole mobility of about 0.04 cm²/Vs. The highly ordered polycrystalline thin film of the F₁₆CuPc can be deposited on amorphous SiO₂/Si substrates under similar optimized growth conditions. Fig. 1 show the related energy levels of the highest occupied molecular orbital (HOMO) is 5.9 eV and the lowest occupied molecular orbital (LUMO) is 4.6 eV of the F₁₆CuPc and the line was indicated the Fermi-level [2, 5].

In this paper, we fabricated the single layer F₁₆CuPc (40nm) FET and we measured the drain current-drain voltage (I_D-V_D), capacitance-gate voltage (C-V_G) characteristics with various applied frequency and observed the AFM images of the F₁₆CuPc thin film surface. The single and double layer FET device have the channel length and width was 50 μ m and 3mm, respectively. The I-V and C-V characteristics were carried out in an ambient condition by using a source-meter (Keithley type-2400) and LCR meter (Hioki type-3522-50) [4, 6, 7].

2. Experimentals

Figure 1 shows a molecular structure and the device structure of the single layer F₁₆CuPc FET. The F₁₆CuPc FET was fabricated using the silicon substrate and the UV/ozone treatment for 30 min with oxygen gas before deposition of the active materials. The F₁₆CuPc were deposited on to the substrate by thermal evaporation method with a deposition rate of 0.5 [Å/s] at 10⁻⁷ torr. The channel length (L) and width (W) were 50 mm and 3 mm, respectively.

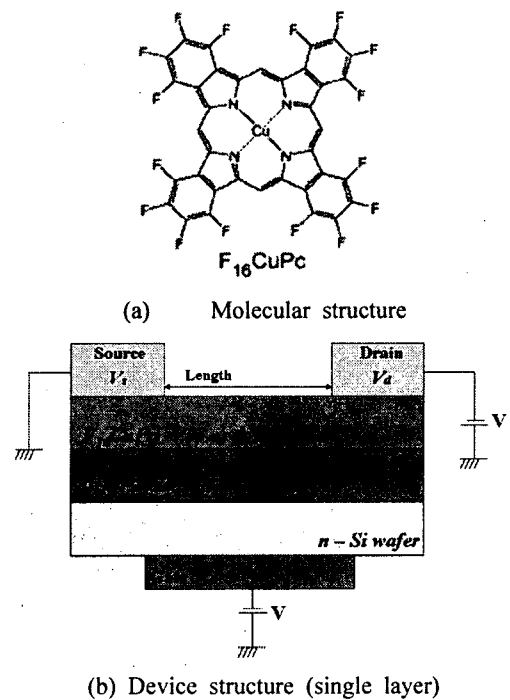
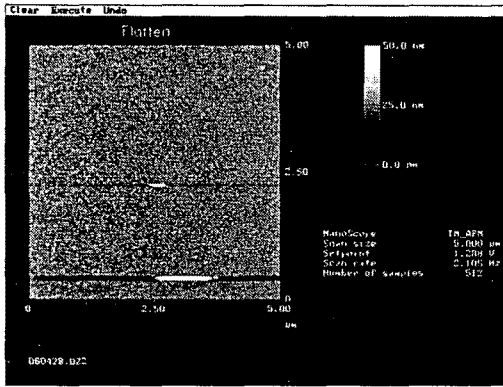


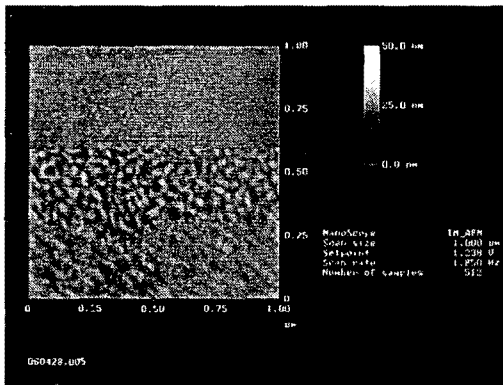
Fig. 1. Device and molecular structures of the F₁₆CuPc FET device.

3. Results and Discussion

Figure 2 shows the AFM images of the bulk $F_{16}CuPc$ thin film surface at room temperature and the $F_{16}CuPc$ thin film thickness was 40 nm. From the large area (Fig. 2. (a)) AFM images we could observe the very smoothly surface characteristics of the $F_{16}CuPc$ organic thin film. Also we could guess that the $F_{16}CuPc$ materials were layered to parallel with the substrate from the small area (Fig. 2(b)) AFM image.



(a) $F_{16}CuPc$ surface morphology ($5 \times 5 \mu m^2$)



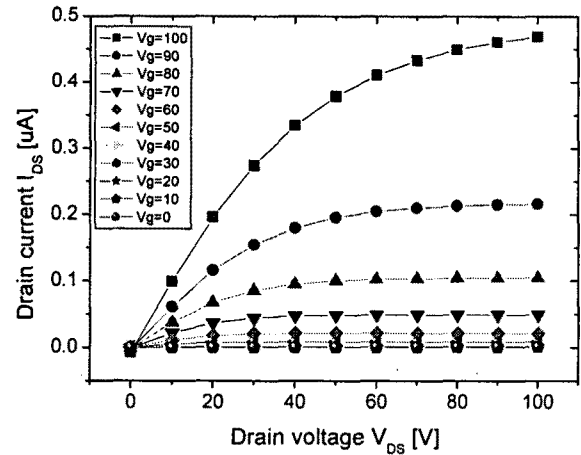
(b) $F_{16}CuPc$ surface morphology ($1 \times 1 \mu m^2$)

Fig. 2. AFM images of the bulk $F_{16}CuPc$ thin film surface at 40 nm.

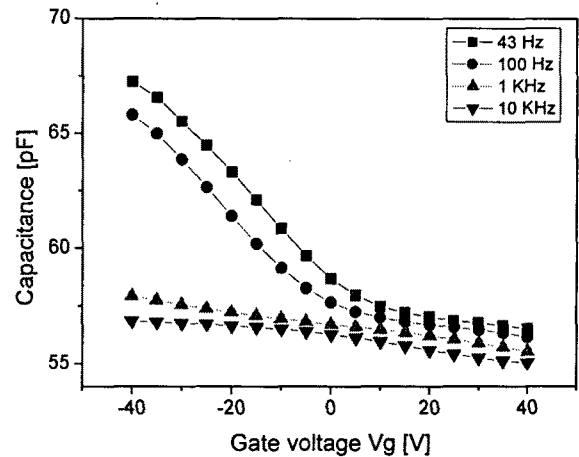
Fig. 3 shows the I-V and C-V characteristics of the $F_{16}CuPc$ single FET. The Fig. 3(a) shows the typical FET characteristics as the n-type characteristics and we were calculated the field-effect mobility of $1.5 \times 10^{-4} \text{ cm}^2/\text{Vs}$.

Also we measured the C-V characteristics of the $F_{16}CuPc$ FET with various applied frequency in Fig. 3(b). We applied the varying frequency 43, 100, 1K, and 10K [Hz] to the $F_{16}CuPc$ FET for the capacitance measurement. The applied gate voltage was increase the capacitance was also increased in the between dielectric

layer and $F_{16}CuPc$ layer in range of the 40V to -40V.



(a) Typical I-V characteristics (n-type)



(b) C-V characteristics with various applied frequency
Fig. 3. I-V and C-V characteristics of the $F_{16}CuPc$ single layer FET.

4. Summary

We fabricated the top-contact $F_{16}CuPc$ FET and we were measured the C-V characteristics of the $F_{16}CuPc$ single FET.

References

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