FIELD-EFFECT TRANSISTOR MADE OF DERIVATIVE PENTACENE

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The use of organic material for the electronic devices has great importance for future application due to its low cost and easy fabrication procedures. Pentacene, one of most promising organic material for device application, has been studied intensively in polycrystalline film[1]. TIPS-pentacene (6,13-bis(triisopropylsilylethynyl)pentacene) was evaporated to patterned electrodes on the substrate in the base pressure of 10^{-6} Torr. Heavily doped Si substrate with 300 nm SiO_2 dielectric layer served as back gate and its gate-voltage dependent I-V characteristics are measured using HP-4155B parameter analyzer.

As shown in Fig. 1 (a), the evaporated film has c-axis orientation and its output characteristics in Fig. 1 (b) show the field-effect transistor with mobility of up to 0.01 cm^2/Vs. This field-effect mobility can be increased up to 0.5 cm^2/Vs with optimization of growth condition and interface modification by adsorbed molecule[2].

Since the wavelength of He-Ne laser (632.8 nm) is above the absorption edge, there is current increase upon illumination as Fig. 2 (a). Unlike semi-logarithmic dependence of phototransistor, linear dependence of I_d vs light power means photoconductivity response. Due to the persistent photoconductivity in TIPS-pentacene, it does not return to original value at room temperature[3]. We measured temperature dependence of TIPS-pentacene transistor after 30 mW He-Ne laser illumination. Its mobility from the saturation region (V_{DS}= -40V) is 0.0068 cm^2/Vs at room temperature and starts to decrease as lowering the temperature. From the temperature dependence its activation energy is estimated as 210 meV, which is higher than pentacene transistor[4].

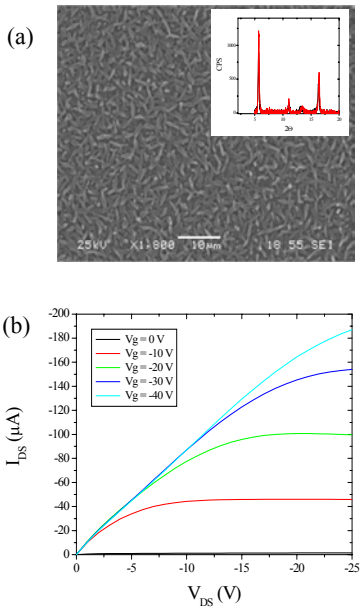

Figure 1. (a) SEM image of thermally evaporated TIPS-pentacene and its XRD. (b) Typical output characteristics of TIPS-pentacene transistor with W/L = 8000.

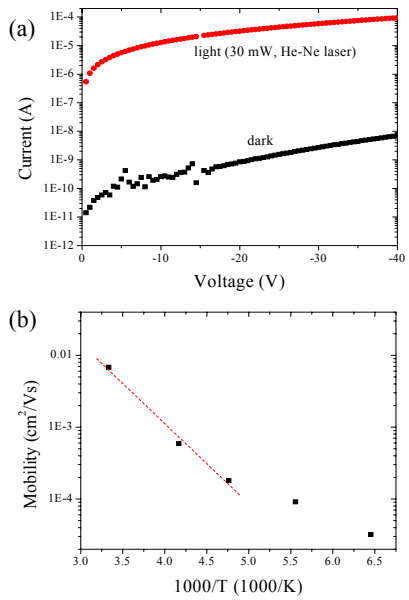

Figure 2. (a) Light response of TIPS-pentacene FET under the illumination of He-Ne laser (632.8 nm). (b) Temperature dependence of field-effect mobility in the saturation regime.

Acknowledgements

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References

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