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Pentacene TFTs using PVP as Gate Insulator

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1. Introduction

In recent years the use of organic semiconductors in field-effect transistors has gained considerable interest due to their potential application in number of low-cost, large area electronics on flexible substrate, such as active matrix displays, smart cards, price and inventory tags, and large area sensor arrays.[1]

In this paper, we have fabricated pentacene thin film transistors (TFTs) using poly(4-vinylphenol) (PVP) copolymer and cross-linked PVP as gate insulator on glass and plastic (PET) substrate. Depending on the density of PVP and cross-link material the performance has been changed. We obtained the best device performance with the mobility of 0.32cm2/V·sec and the on/off current ratio of 1.19×106 for the case of 10wt% PVP copolymer mixed with 5wt% poly (melamine-co-formaldehyde). Additionally using pentacene TFTs with the above PVP gate insulator, we fabricated the integrated circuits including inverter which produced the gain of 9.7.

2. General Instructions

PVP as organic gate insulator was spread through spin-coating and baking covering in part after we patterned ITO on glass. Then we evaporate the pentacene by OMBD and deposit Au as top electrode. PVP copolymer is mixed with PVP (poly-4-vinylphenol) and PGMEA (propylene glycol monomethyl ether acetate) and cross-linked PVP is fabricated mixing PVP after adding poly(melamine-co-formalde hyde) in PGMEA as solvent. Spin-coating condition is 3000rpm, 30sec and baking condition is that PVP copolymer is 30min in 100℃ and cross-linked PVP is 5min in 200℃ after 10min in 100℃. Each thickness is about 2700Å.

TFTs' drain current transfer curve is measured by HP4155A from 10V to -40V at intervals of -0.2V. Fig. 1 and fig. 2 shows the transfer curve depending on PVP density and poly (melamine-co-formaldehyde) density with 10wt% PVP.

We can know that the performance has been changed depending on the density of PVP and poly (melamine-co-formaldehyde). The result of the all parameters, 10wt% PVP copolymer and cross-linked PVP mixed 10wt% PVP copolymer and 5wt% poly (melamine-co-formaldehyde) have the best characteristic.

10wt% PVP copolymer's mobility and on/off ratio is 1.65cm2/V·sec, 1.06×103 respectively, and off current was 6.63×10-8A. On the other hand, mobility and on/off ratio of cross-linked PVP are each 0.32cm2/V·sec and 1.19×106A, and off current is 1.15×10-11A. Fig 4 and Fig 5 are transfer curve and output curve with cross-linked PVP.

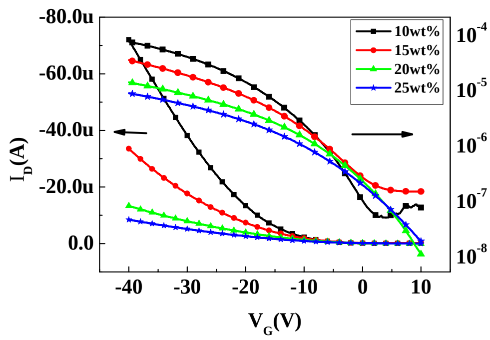

Fig.1 Transfer curves depending on PVP density

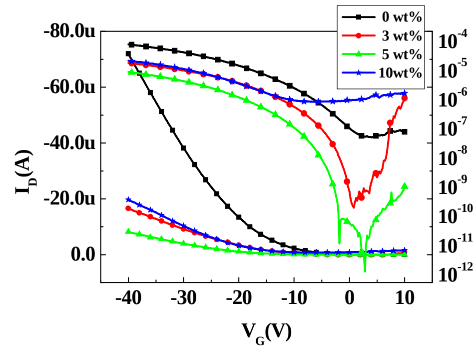

Fig. 2 Transfer curves depending on poly(melamine-co-formaldehyde) density with 10wt% PVP

Fig. 3 is actually made circuit on plastic (PET) that is involving fabricated inverter and 5-stage ring-oscillator using cross-linked PVP as gate insulator.

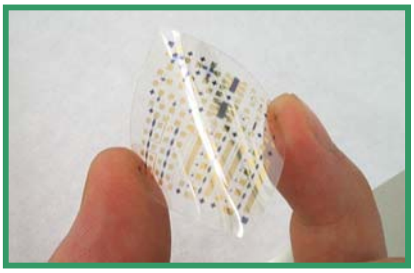

Fig. 3 Integrated Circuit on the PET

At first, we deposit Ti/Au as bottom electro and spread cross-linked PVP. After then, we etch bottom electrode for open of inter-connect using RIE and deposit the top electrode through the lift-off. This processing needs lithography processing using PR and acetone. So, we should use cross-linked PVP as gate insulator. The last process is evaporating the pentacene using OMBD

Fig. 4 and Fig. 5 are showing characteristics of inverter fabricated on the glass and plastic substrate respectively. When we measure the characteristic of inverter using HP4155A, we impress V_{DD}=-20V, V_{SS}= 0V and set 100ms both hold time and delay time. The gain of inverter fabricated on the glass was 5.56 and gain of inverter fabricated on the PET was 9.71. The threshold voltage was +8V and +14V respectively.

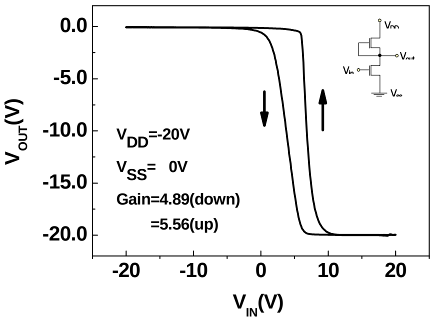

Fig. 4 Transfer Characteristic of Inverter on Glass

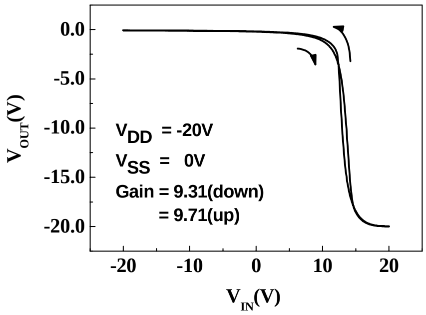

Fig. 5 Transfer Characteristic of Inverter on Plastic

3. Conclusions

In this paper, we fabricate pentacene TFT using PVP copolymer and cross-linked PVP as gate insu -lator on glass substrate. In case of PVP copolymer gate insulator, mobility and current on/off ratio are respectively 1.65cm^2/V·sec and 1.06×10^{3}A. And cross-linked PVP's mobility and current on/off ratio are 0.248cm^2/V·sec and 1.45×10^{5}A.

We also make integrated circuit which is includ-ing inverter and ring oscillator using cross-linked PVP on glass and plastic substrate and attain invert-er property 5.56, 9.71 separately.

Acknowledgement

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