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Fabrication and Performance of Pressure Sensor Device consisted of Electrets film and Organic Semiconductor

Takehito Kodzasa[1], Daiki Nobeshima[1], Kazunori Kuribara[1], Sei Uemura[1] and Manabu Yoshida[1]

[1] National Institute of Advanced Industrial Science and Technology
Flexible Electronics Research Center
Central5 1-1-1 Higashi, Tsukuba, Ibaraki 305-8565, Japan
Phone: +81-29-861-4536 E-mail: tak-kozasa@aist.go.jp

Abstract

We propose a new concept of pressure-sensitive device which consists of electrets and organic semiconductor. This device with the simple structure achieved high sensitivity and selectivity to various kind of stress. This enables to fabricate complicated sensor allay by the manufacturing system such as printed electronics.

1. Introduction

The development of low-cost, large-area and flexible electronic sensor is greatly attracting interest for the demand of the pressure sensitive input device like the latest high-performance touch panel. Especially, in the recent year, the low-pressure sensor sheet devise with sufficient high sensitivity give greatly interested from the viewpoint of the IoT sensing, wearable healthcare devices and electronic skin for robotics. We fabricate a new type of organic thin film pressure sensor device structure. The device consists of an organic semiconductor thin film and charged electrets thin film. Organic semiconductor device has the advantage for their light weight, flexibility and good reducibility by printing technique. In this research, we show the new type of pressure sensing device has high potential industrially and academically.

2. Experimental

Figure 1 shows a schematic diagram of the new type of pressure sensor device. Gold or Indium Tin Oxide (ITO) electrode are prepared on the glass substrate by the masked sputtering method. Distanse between electrodes is 50μm and width of electrodes is 5mm. Poly(3-hexylthiophene) (P3HT),which is purchased from American Dye Source inc., is used for the organic semiconductor material. P3HT is dissolved in 1,2-dichlorobenzene and spread to electrodes by the spin-coating method. Poly(tetrafluoroethylene) (PTFE), Poly(vinylidene fluoride) (PVDF) and CYTOP™ fluoric polymer are used for the electret thin film. CYTOP ™ solution, which is purchased from Konishiyasu co., ltd., is spread on a glass substrate by the bar coating and heated to 200°C in the oven before the charging process. Thickness of CYTOP ™ thin film are in the range of 4-10μm. PTFE and PVDF film with the 100μm of their thickness are used with no supporting substrate. Their fluoric polymer thin films are charged by the corona discharge process at 19-20°C. Applied voltage for the corona discharge is -4.5kV. Surface voltage of electrets fluoric polymers are in the range of -200V to -400V. Electrets thin film is put on the P3HT-electrodes diode with or without inserting spacer plate. Silicone rubbers are used for the spacer plate. Various kind of stress are applied to the sensors by the brush, pen, finger and weight for the estimating the performance of the sensor device,. Negative voltage in the range of -1 to -40V is applied to electrodes and currents between the electrodes are observed.

3. Results and discussion

Figure 2 shows the pressure sensing mechanism of this device. This device is derived from a variation of conductivity of organic semiconductor layer with the relative distance to the electrets thin film. Figure 3 shows the change in the resistance between electrodes of the pressure sensor device with CYTOP ™ for the electrets thin film. This indicates that electric signal against applied pressure have variations depending on the kind of pressing behaviors. When the stress is weak and unstable such as tracing or brushing, their signals show the vibration structure. When the stress is strong and stable such as pressing or pushing, their signals show the change of resistance which is in proportion to the strength of pressure. This indicates that the kind of stress can be distinguished from the strength and structure of the signals. We attempted to produce (4X4) transparent sensor allay sheet consist by 16 devices. CYTOP and ITO as the component materials are selected for making it transparency. Figure 4a shows the photograph of transparent sensor allay sheet on the glass substrate prepared in this research. This is connected to the multi-channel source meter and corrected electric current for the each device. Figure4b shows the picture of visualization of the variation of currents for each sensor device. This also shows current is in proportion to the strength of pressure. It is expected that these integrated sensor device plays highly effectively for the position sensitive sensor sheet.

4. Conclusions

When the sensor allay sheet is prepared by the large size manufacturing system, it is not needed fine adjustments for the lamination. This means the new structural device make not only interesting academically but also fruitful industrially.

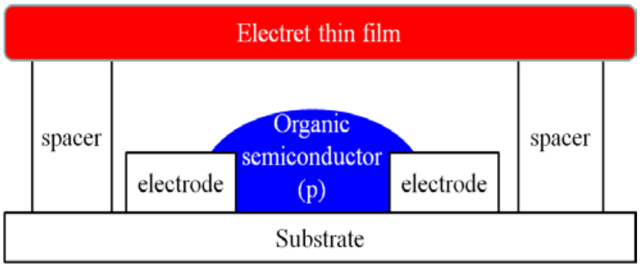

Figure 1　schematic diagram of the new type of pressu sensor device

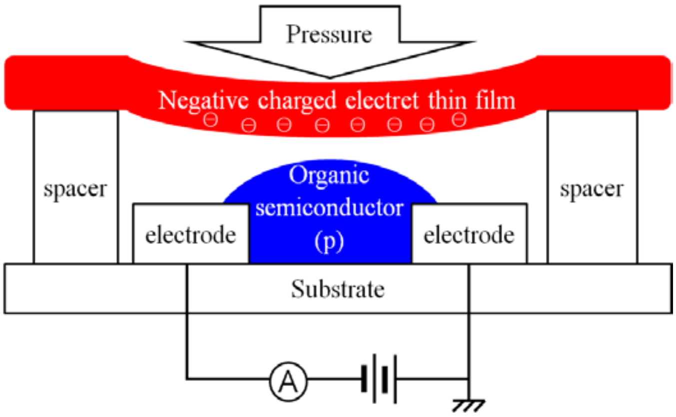

Figure 2　mechanism of pressure sensing for this device

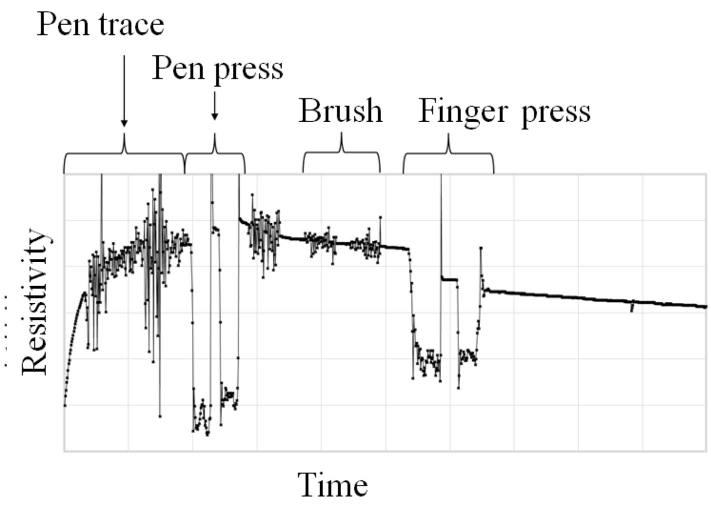

Figure 3　plot for variation of resistance against various kind of stress

Figure 4a　photograph of transparent sensor allay sheet

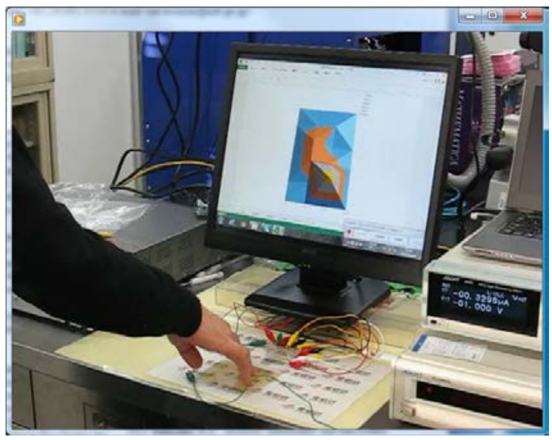

Figure 4b　picture of visualization of the variation of currents for each sensor device