Effect of electrical characteristics by surface modification in pentacene field effect transistor with thin Al_2O_3 gate oxide layer

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Since the organic materials with high conductivity were discovered, organic materials have been attracting attention due to their applicability of large area, low cost, and flexibility[1]. However, the devices using organic materials still have critical technical issues such as mobility[1], operating voltage[2], and stability[3].

As reported previously[4], the high mobility of device is incompatible with the low operating voltage of device: devices using low-k materials were generally operated at high voltage over –10V despite high mobility. On the contrary, devices using high-k materials had the low operating voltage. However, its mobility was significantly decreased owing to charge carrier localization and trapping at interface layer between gate oxide and organic semiconductor.

In this study, surface modifications such as self-assembled monolayers (SAMs) and polystyrene (PS) polymer were carried on Al_2O_3 high-k material to satisfy the high mobility as well as the low operating voltage. We investigated the electrical characteristics of pentacene OFET depending on the various surface modifications. In case of OTS treated device, subthreshold swing and threshold voltage are remarkably improved due to the low interface trap density. In case of PS-FGA treated device, it is found that high field (> –2.5×10^5V/cm) drain current is significantly improved despite high threshold voltage and subthreshold swing. Based on the results, devices with high mobility as well as low threshold voltage will be realized.

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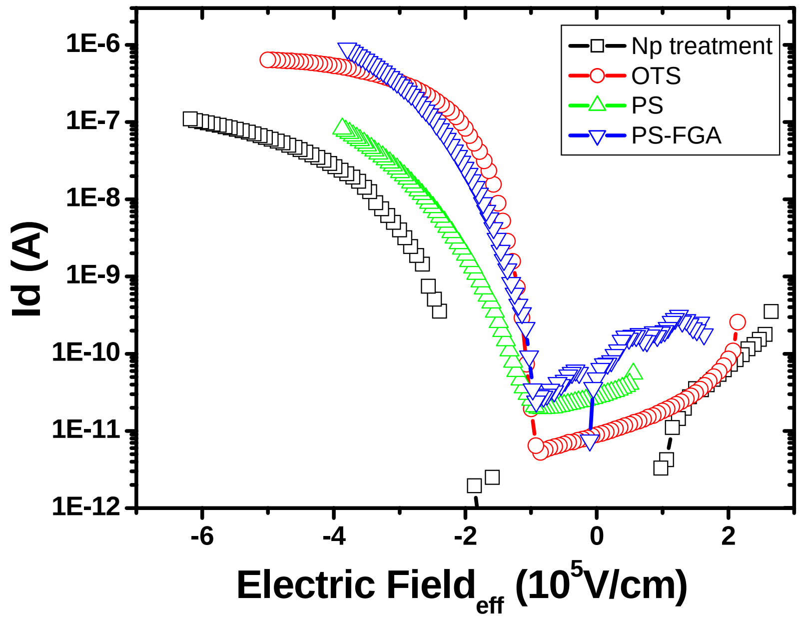

Fig. 1. The I–E characteristics for pentacene FET

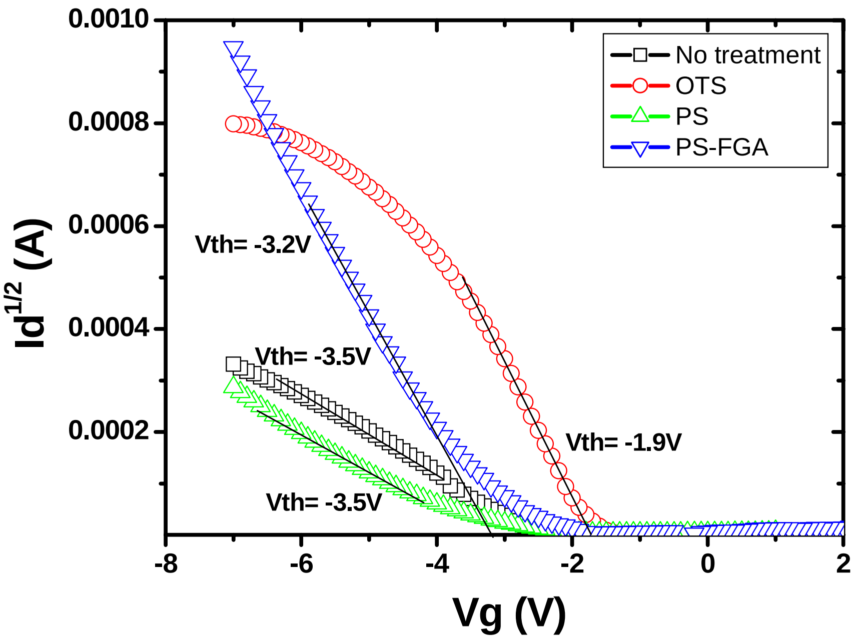

Fig. 2. The plot of $I^{1/2}$–V characteristics for pentacene FET