Temperature Dependent Transport Properties in dinaphtho[2,3-b:2',3'-d]thiophene Thin-Film Transistors with MoO_3/Au Electrodes

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【Introduction】Organic thin-film transistors (OTFTs) have recently attracted a great deal of interest for organic electronic applications, such as flat panel displays, electronic paper, and radio frequency identification tags. In particular, hexyl-substitued dinaphtho[2,3-b:2',3'-d]thiophene (C6-DNT-V) is considered to be one of the most promising organic semiconductors in OTFTs because of its high hole mobility. Recently, study on charge transport in OTFTs has become an important subject for improving device performance of transistor. The OTFTs can be improved by inserting metal oxide, such as molybdenum oxide (MoO_3), germanium oxide (GeO) and tungsten oxide (WO_3) between electrode/semiconductor interface.[1] In the previous work, temperature dependence in pentacene and C8-BTBT OTFTs with MoO_3/Au electrodes have been reported.[2-3] In this study, we have investigated gate-bias and temperature dependence in C6-DNT-V TFTs by inserting MoO_3 between C6-DNT-V layer and Au electrodes. Temperature dependence voltage-current (V_D-I_D) characteristics from 133 K to 293 K with different gate-bias voltage were measured to evaluate possible charge transport mechanism in C6-DNT-V thin film.

【Experimental】 The device were fabricated on n-type silicon substrate with 100 nm SiO_2 layer, using 40 nm C6-DNT-V as the active layer in a top-contact structure. Finally, 5 nm MoO_3 and 50 nm Au were deposited as source and drain electrodes. The channel length (L) and channel width (W) were 0.5 mm and 1.5 mm, respectively. To investigate the charge transport mechanism, the device was cooled down using a cryostat. The V_D-I_D characteristic was measured in the temperature range between 133 K and 293 K by flowing liquid nitrogen into the vacuum chamber.

【Results and discussions】Fig. 1 shows V_D-I_D characteristics with different V_G in the temperature range between 133 K to 293 K. Temperature dependence V_D-I_D characteristics can be explained with two possible charge transport mechanisms which are Schottky thermionic emission and polycrystalline model at ground boundary.[4] In the low applied voltage region, temperature dependent V_D-I_D characteristics can be fitted by the Schottky thermal emission mechanism model (barrier height range from 33 to 57 meV), as shown in Fig. 2. On the other hand, in the high applied voltage region, temperature dependent V_D-I_D characteristics can be fitted by the polycrystalline model (barrier height range from 49 to 73 meV), as shown in Fig. 3. By applying gate voltage, the barrier height was decreased with increase in the negative gate voltage.

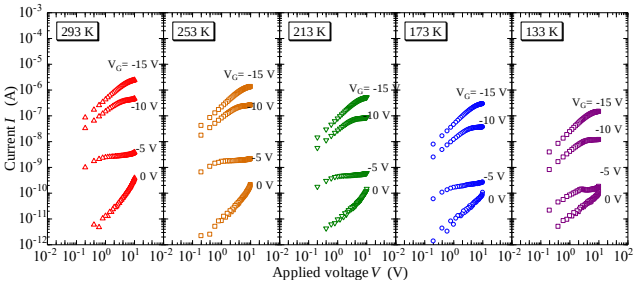

Fig. 1

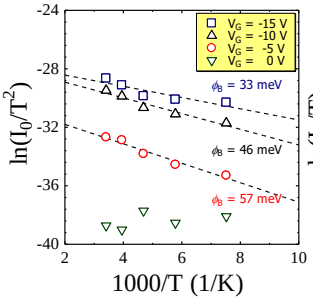

Fig. 2

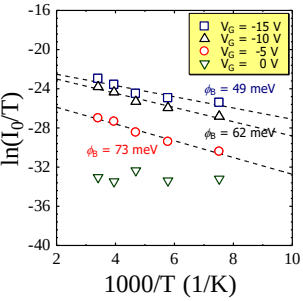

Fig. 3

【References】

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