Solution-Processed Organic Field Effect Transistor using a Liquid Crystalline Semiconductor, 8TNAT8

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In the field of organic electronics, solution-processed organic semiconductors for large and flexible electronic devices which are fabricated by low temperature process, in particular field effect transistors (FETs) have gotten much attention in these years. Numerous of the characteristic properties of liquid crystalline semiconductors, such as their self-assembling nature, ambipolar charge transport, electrically inactive domain boundaries, and good solubility in ordinary organic solvents, make them attractive candidates for application in FET devices.

Calamatic liquid crystalline semiconductors have the advantage of achieving the 2D hopping conduction required for lateral type TFTs, in contrast to the 1D hopping conduction shown by disc-shaped molecules. Recently, we reported that a calamatic liquid crystalline semiconductor, 2,6-di(5'-n-octyl-2'-thienyl)-naphthalene (8TNAT8) showed a hole mobility of 0.1 cm² V⁻¹ s⁻¹ in a 3D mesophase and a p-type FET mobility of 0.14 cm² V⁻¹ s⁻¹ in a polycrystalline thin film which was vapour deposited for a top-contact/bottom gate device.¹,²

In this study, we used a liquid crystalline semiconductor, 8TNAT8, solutions (e.g. 0.1 wt% in toluene) for forming an organic semiconductor layer by solution casting method, and fabricated bottom-gate/bottom-contact type FET devices which are more suitable for using printing processes. This LC semiconductor shows FET characteristic properties and has a high carrier mobility of 0.01 cm² V⁻¹ s⁻¹ in a bottom-gate/bottom-contact type FET device at room temperature. We have also investigated the influence of surface morphology and FET properties of fabricated FETs at various temperatures.

References:

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