Abstract of diploma thesis
«Ambipolar charge transport in organic semiconducting crystals»

Semiconducting crystals of π-conjugated oligomers are perspective materials for organic optoelectronics combining high luminescent properties and efficient charge transport. These properties are often incompatible because of the strong intermolecular interaction that is necessary for charge transport but usually lead to luminescence quenching. To create electroluminescent device such as organic light emitting diodes (OLEDs) or light emitting field effect transistors (LEFETs), one has to inject both holes and electrons into active layer for its emitting recombination. The aim of this work is to study materials which have outstanding luminescent properties (PL EQE up to 60%) and create ambipolar field effect transistors based on the crystals of this materials. The materials are TMS-PTTP-TMS, CF3-PTTP-CF3 and BPFB.

Unipolar field effect transistor based on vacuum sublimed films of TMS-PTTP-TMS and CF3-PTTP-CF3 were shown. The first shows unipolar p-type regime of work while the latter, which has lower LUMO level caused by fluoridation, shows unipolar n-type regime with mobility up to 0.02 cm^2/Vs.

Setup for physical vapor deposition method of crystal growth were built. Setup allows to automatically connect main growth parameter – gas flow rate, heater and thermostat temperatures. Electronic properties of grown crystals were examined, all of them show unipolar regime of p- or n-type.

The shadow effect was used to fabricate crystal based transistors with asymmetrical calcium-gold electrodes. In this case gold is injecting holes and calcium is injecting electrons. This method were successfully applied to AC5 material which is well known from the literature. Ambipolar regime was realized with balanced mobilities up to 0.01 cm^2/Vs for both types of charges which is comparable with numbers obtained in literature. Shadow effect were also applied to the crystals of studied materials and TMS-PTTP-TMS have shown ambipolar regime as well. Mobilities are also balanced and about 0.003 cm^2/Vs, that is one order of magnitude lower than for AC5 but can be further increased. It makes these crystals with extremely high PL EQE of 60% very perspective object to LEFET fabrication.

Method of lamination of gold electrodes instead of its evaporation have showed significant decreasing of hole threshold voltage for unipolar OFETs based on BPFB crystals. It is proved that threshold voltage is correlated with the way of gold deposition. Evaporation is lead to creating defects in the metal-semiconductor interface that is impedes charge injection. Gold lamination can be combined with evaporation of low work function metals to be applied for a fabrication of ambipolar and light emitting OFETs with improved characteristics.

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