Abstract of diploma thesis

«Photoluminescence of Oligothiophene-Phenylene Crystalline Films»

Semiconductor crystals of thiophene-phenylene π-conjugated oligomers (TPCO) are perspective materials for organic optoelectronics combining high luminescent properties and effective charge transport. These properties are often incompatible because of strong intermolecular interaction that is necessary for charge transport but usually lead to luminescence quenching.

Single crystals of two TPCOs with the same π-conjugated cores (phenylene-thiophene-thiophene-phenylene, PTTP) and different terminal substituents (thrifluoromethyl, CF_3, and trimethylsilyl, TMS) have been studied in this work. Photoluminescence quantum yield (PL QY) of TPCO single crystals crystallized from solution and vapor phase was measured. Solution-grown crystals were found to luminescent more effectively than vapor-grown ones.

The record PL QY (47%) among insofar reported for TPCO crystals was obtained in the work. PL QY of studied crystals is 2–3 times higher than that in solutions and reabsorption-corrected PL QY of pure single crystals exceeds 50%. It was shown that record PL QY in solid phase caused by intermolecular interaction of TPCO in a well-ordered crystalline structure.

Time-resolved PL measurements in TPCO solutions and crystals were carried out. Radiative and non-radiative PL rate constants in TMS-PTTP-TMS solutions and crystals were calculated. It was concluded that improvement of PL properties was caused by suppression of radiationless PL decay. We has found a significant influence of a strongly luminescent impurity on PL properties of TPCO single crystals. A kinetic model explaining energy transfer between the main TPCO molecules and the impurity was proposed. The model allowed us to determine the characteristic PL lifetimes and estimate the time of energy transfer.

Significant improvement of luminescent properties in TPCO single crystals caused by an impurity can help growing TPCO crystals with high PL QY. The record PL efficiency in combination with high charge carrier mobility make CF_3-PTTP-CF_3 and TMS-PTTP-TMS single crystals extremely promising materials for light-emitting field effect transistors and organic injection lasers.

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