

The observed progress in organic chemistry actually leads to advanced capabilities of synthesizing of electroactive organic molecules of more complex and sophisticated molecular and electronic structure. In general, using a strategy called "building block approach" new electroactive molecules can be synthesized by appropriate coupling of chemical segments of different electron accepting/donating properties. As a consequence new organic molecules of precise tuned electronic and optoelectronic properties can be fabricated. Actually, this ability is a strong advantage for applications of organic semiconductors in various novel technologies and devices, like: chemical sensors, devices of molecular electronics (OLEDs, OFETs), photovoltaic (solar cells), etc. However, the another factor which seriously influences the final properties of organic electronic devices (including charge transport, emission spectra and efficiencies of emitting diodes, etc) is supramolecular organization in the active organic layer. Let's remind, that contrary to metals the movement of charge carriers in organic molecules is strongly anisotropic with preferential direction determined by their supramolecular organization. Usually, the effective mobility in the layer is limited by the weakest point in a conduction path which is a transfer of charge carriers between molecules. As a consequence the mutual arrangement of neighboring molecules in the layer and intermolecular separation are important factors. Moreover, local disorder constitutes another weak point significantly lowering the mobility of charge carriers. The progress in this field is expected to be reached by the use of well-defined ordered thin organic layers. The supramolecular abilities of organic semiconductors can be controlled by the attachment to molecular backbone additional terminal units, usually containing long alkyl substituents, which facilitate molecular ordering through interdigitation. Knowledge concerning supramolecular interactions and resulted molecular selforganization of these complex in topological and electronic structures molecules is therefore essential in the optimization of organic electroactive systems.

The proposed research is directly dedicated to this problem. We are going to use novel microscopic techniques (scanning tunneling and atomic force microscopies) to study at molecular resolution the topology of ordered monomolecular and thin layers of new organic semiconductors of donor-acceptor structure (DA). The molecules representative of two important families of organic electroactive materials – DA derivatives containing thiophene rings and differently functionalized arylene bisimides will be investigated. Then, a correlation of layer structures, determined by microscopic measurements, with the size and the geometry of the studied molecules enable to postulate for each system a model of molecular organization and the distribution of supramolecular interactions. Our strategy is to synthesize for each semiconductor logically designed series of derivatives differing in details of molecular structure (for example: by different position and size of the donor or acceptor units in the conjugated core or terminal substituents). In this way our comparative microscopic investigations should provide a precise information concerning role of different units of the complex in structure molecules on the supramolecular organization (interactions). As a final result we expect to stipulate more general rules for molecular engineering enabling precise tuning of the distribution and balance of supramolecular interactions in each investigated molecular system.