Macromolecules with alternating double and single bonds in the backbone are called conjugated polymers (CPs). These semi-conducting materials after chemical modification (doping) may demonstrate as high conductivity as metals. However, most CPs in their doped state are quite unstable, therefore their use for production of electric devices is rather hindered. Fortunately, doping of some CPs by charged polyelectrolytes may solve the mentioned problems. That is why the polymer mixture based on poly(3,4-ethylenedioxythiophene) doped with poly(sodium 4-styrenesulfonate) (PEDOT:PSS) is the most popular in the field of CPs. PEDOT:PSS is considered as a promising material for replacing of electrodes based on inorganic conductors in different applications such as: organic solar cells,[1] organic light-emitting diodes,[2] etc. Unfortunately, spin-casted PEDOT:PSS films demonstrate out of plane (vertical) conductivity (more important for most of applications) up to 3 orders of magnitude lower than in-plane one. Moreover, taking into account general problems with low stability of spin-casted and drop-casted films (thermal degradation, delamination) it seems that the full potential of such powerful polymer mixture is still untapped. Charge transport mechanism in such a layers still needs deeper understanding, however its detailed investigation for spin-casted layers with poorly ordered macromolecules in the bulk is hindered.

Thus, the main goal of the project concerns synthesis and extensive characterization of novel material: binary-mixed polymer brushes with precisely and vertically aligned macromolecules (in extended conformation) that resembles PEDOT:PSS structure and combines its excellent properties with improved mechanical stability due to covalent attachment to the surface. The binary-mixed brushes in this project will be obtained by intermixing of surface-grafted ladder-like conjugated brushes (LLCB) with polyelectrolyte ones (PELs) (serving as dopants) on indium tin oxide surface. Such system is expected to form molecularly ordered and self-doped thin polymer layers with anisotropic conductivity in out of plane direction with respect to the surface. The successful synthesis of such platforms of molecular wires can be recognized as a breakthrough in organic electronics, and be a milestone towards the formation of stable and effective thin film organic conductors for emerging applications such as: ordered heterojunction solar cells, nanosensors or nanoelectronics.

The planned structural and electrical characterization of binary-mixed polymer brushes by means of high resolution Atomic Force Microscopy would deliver valuable information concerning detection of possible nanodomains, interpolymeric complexes or distribution of highly conductive spots on the sample surface. Application of dip-pen nanolithography for precise arrangement of LLCB and PELs on the surface will help to investigate the mutual interactions occurring between CPs and charged polymers. The project will provide new and versatile synthetic methodology that could be used for production of almost any kinds of binary-mixed brushes. The designed experiments and research procedures within the proposal are innovative and should provide valuable information for broad scientific community about the charge transport mechanism in the binary-mixed brushes and ionic/conjugated polymer mixtures.

[1] Thomas, J. P et al. *ACS Nano* **2018**, *12*, 9495-9503.
[2] Zhou, L. et al.. *Adv. Funct. Mater.* **2018**, *28*, 1–7.