

## DESCRIPTION FOR THE GENERAL PUBLIC

The main aim of the research project is the characterization and optimization, in terms of mechanical and electrical properties, of the thin-film system consisted of organic nanostructures supported on semiconducting substrates. To construct these thin organic films we will use rod-like molecules of *para*-hexaphenyl (6P) and pentacene (5A) with a relative simple construction but characterizing with a number of interesting optoelectronic properties. Furthermore, they possess self-organizing properties allowing to create highly-ordered structures with crystalline in nature. The order parameter, arrangement orientation and stability to external factors of the mentioned nanostructures can be controlled by a change of a substrate conditions where in the role of the substrate it will be used (110) surface of titanium dioxide (TiO<sub>2</sub>) – otherwise known as rutile. The surface change can be induced by ion beam modification, whereby the substrate is functionalized in terms of diffusion properties, e.g. in a form of strongly anisotropic ripples on the TiO<sub>2</sub> surface [1]. The chemical modification by air passivation prior to 6P/5A molecules evaporation should have also a significant influence to the interaction strength between molecules and the passivated substrate [2]. Additionally, an important aspect of the planned research is study of received nanostructures in long-term regime, where a deeper understanding of atmospheric/weather conditions impact on the stability and possible degradation is a crucial issue waiting to resolve.

Organic nanostructure properties and their changes will be investigated by means of a row of surface-sensitive techniques, like scanning probe microscopy (SPM) in different modes or scanning electron microscopy (SEM). The combination of these two experimental methods will give the possibility to investigate large areas with high resolution (HR-SEM) and to obtain information about electric properties by using, e.g. scanning tunneling microscopy (STM) or Kelvin probe force microscopy (KPFM). Tracking the exact changes in the organic structures morphology after various “ageing times” in controllable conditions (humidity, temperature and atmosphere) will be possible thanks to non-contact (NC-AFM) or tapping mode atomic force microscopy (TM-AFM). To reveal a long-range ordering, both in the case of molecules within one layer and ion beam modified TiO<sub>2</sub> substrate, will serve a low energy electron diffraction (LEED) method.

The study of the surface influence and mentioned environmental conditions impact for the “ageing process” and its contribution to the mechanical and electrical properties of the thin organic films is highly desirable in view of potential application in devices like: organic field effect transistors (OFET), organic light-emitting diodes (OLED) or solar cells. The specification of listed electronic components work requires durability and a stable operation on adequate level for as long as possible. Therefore, a systematic study of influence of factors such as elevated humidity or temperature is very important not only from our point of view, but also from organic electronics, which very dynamic development in recent years is clearly noticeable almost in every aspect of our daily life. A huge requisition for electronic devices with ever-increasing power, efficiency and durability while maintaining smaller and smaller sizes causes increasing interest in basic research in the field of nanotechnology, especially connected with surface functionalization and thin organic film growth optimization.

[1] M. Kratzer, D. Wrana, K. Szajna, F. Krok, C. Teichert, Island Shape Anisotropy in Organic Thin Film Growth Induced by Ion beam Irradiated Rippled Surfaces, *Phys. Chem. Chem. Phys.* **2014**, 16, 26112-26118

[2] D. Wrana, M. Kratzer, K. Szajna, M. Nikiel, B. R. Jany, M. Korzekwa, C. Teichert, F. Krok, Growth of *Para*-hexaphenyl Thin Films on Flat, Atomically Clean versus Air-Passivated TiO<sub>2</sub>(110) Surfaces, *J. Phys. Chem. C*, **2015**, 119, 17004