

Fabrication and optimization of photonic components by electron and ion beam induced polymerization of ionic liquid monomers

The project *Fabrication and optimization and optimization of photonic components by electron and ion beam induced polymerization of ionic liquid monomers* is devoted to new polymer technology for high-resolution structuring of the layer on a planar substrate (Si, Glass) according to a design. The structure of the layer is obtained by selective irradiation with electron- or ion beam that alters its properties in the place of illumination.

During years the research has evolved towards novel functional materials in order to find an ideal material platform for a wide range of custom-tailored applications. The demand for new methods of nano- and micro structuration increased due to the increasing number of new applications in polymer photonics. A special interest belongs to polymer sensor and biosensors, creating a need of new material platform for cheap and disposable systems. Currently, several material platforms coexist for different photonic components, however polymeric materials have few unique properties. The most important advantages of polymer is the compatibility with different kinds of substrates (glass, silicon, ceramics) and high tailoring freedom.

The materials selected for the new method is an ionic liquid which, due to the specific molecular form is a unique architecture platform, on which, at least potentially, one can modify the properties of both cation and anion matching material requirements. Ionic liquids - salts defined as consisting of separate cations and anions, whose melting point is below 100⁰C - are known for years as a unique state of matter with specific properties. The popularity of ionic liquid is growing steadily in the last 20 years. Due to the very low vapor pressure of ionic liquids it became possible to place them in the high vacuum chambers and use processes such as deposition of metal or dielectric layers.

In the project we want to use the modified ionic liquids ability to polymerize under the irradiation of the electron- or ion beam in a high vacuum chamber of scanning electron double-beam microscope. Very small beam size (tens of nanometers) will induce the creation of new high resolution design in the ionic liquid layer. Analysis of this process will help to understand the effects that occur in the layer and improve the material. The monomers will be washed out of the film with water or an alcohol, similar like in the process of optical or electron lithography wherein rinsing or dissolving is carried out with the lithography developers. The method will be tested for pure ionic liquids, their mixtures and modified or doped ionic liquids. Dopants will bring additional functionality to the layer, such as high refractive index, improved stability or light emission. In the project we will also examine the possibility of using structured samples for the replication process (nanoimprint).

The project is based on the cooperation of two groups: WBC EIT+ and Foundation of A.Mickiewicz University in Poznan. The research work includes the design of the polymerizable liquids, monomer synthesis, material characterization, computer simulations, the polymerization in electron microscope chamber and fabrication of basic photonic structures.