Popular science abstract

Polymer coatings produced by physical vapor deposition (PVD) methods are increasingly becoming an important area of technology in medicine, optics, and optoelectronics. Among various methods, the most commonly used are pulsed laser deposition (PLD) and radio frequency magnetron sputtering (RF-MS). Another technique, which is hitherto less popular, for producing thin polymer coatings is pulsed electron beam deposition (PED). The attractiveness of this method is primarily due to the much higher degree of preservation of the chemical structure of the deposited polymer and the lower roughness and greater transparency of the obtained coatings. In addition, the costs of the process using an electron gun are much lower than when using a laser.

A commonly accepted mechanism of the PED process for metallic and ceramic materials is that the material exposed to a pulsed electron beam of low energy, but high density, becomes explosively dispersed (so-called ablation), goes into a vapor / plasma state, before being deposited on the substrate. The intensity of this phenomenon is determined by the thermal conductivity and evaporation temperature of the target. However, due to the high molecular weight and numerous physical intermolecular interactions, polymers do not have a vaporization point and some of them, such as polysaccharides, do not even have a melting point. Therefore, the commonly accepted PED deposition mechanism cannot be applied to polymer coatings.

Moreover, the studies on polymer coatings deposited with other PVD techniques, documented in the literature, **do not sufficiently explain the mechanisms allowing the transfer of such large macromolecules** or **the phenomena leading to the preservation of the original polymer structure after the deposition process**.

The aim of the project is **to understand the mechanisms of transfer of polymers by the PED method and to identify potential new application areas** (e.g. for coatings made of organic compounds). To achieve this goal a series of experiments comprising the production of coatings by electron beam ablation of a number of materials were planned: from mono-, di- and trisaccharides, through oligosaccharides, and ending with polysaccharides. This bottom-up approach will allow for the verification of hypotheses concerning the transfer mechanisms of polymers depending on their molecular mass and the functional groups present. The key advantage of saccharides in the context of this research project is that even monosaccharides are solids that can be used as a target and they are chemically resistant.

In this project, both the ablated targets and the produced coatings will be characterized using spectroscopic and microscopic techniques in order to understand their chemical structure and elucidate the deposition mechanisms. Additionally, tests of mechanical properties, degree of crystallinity and wettability will be carried out. This will be supplemented by the study of biological properties in comparison to coatings produced by the traditional dip-coating method.