Proposed topics for research projects 2024/2025 in the *materials engineering discipline*

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Electrically conductive thermoplastic composites modified using various types of lasers

Nowadays, most of the high technology devices comprise elements of polymer-metal interfaces. Depositing metals onto polymer surface is a key process in production of automotive panels, printed circuit boards, three-dimensional moulded interconnect (3D-MID), labs-on-chip, and many other devices. The most common industrial methods of metal deposition is electroless chemical metallization. Obviously, electroplating of conventional thermoplastic polymers cannot be directly conducted due to the lack of their electrical conductivity, and this technique is used as subsequent to those priory creating conductive layer on the polymer surface.

The aim of the project is to obtain, as a result of laser ablation, the electrically conductive surface layer of thermoplastic composites, which enables their selective electroplating metallization (only on the laser irradiate area), while maintaining the dielectric properties of the non-irradiated part. Moreover, in addition to the dielectric properties of the composites, they are supposed to have excellent electromagnetic shielding properties.

To achieve this goal, new thermoplastic composites containing specially tailored conductive additives will be developed. Various combinations of these additives will be used to determine the optimal properties of the composites before (insulating structure) and after (conductive surface structure) laser irradiation.

The developed materials will undergo laser ablation processes to remove the polymer matrix from the surface layer, while increasing the concentration of conductive additives. The ablation processes of the composites will be performed using various types of laser radiation (from ultraviolet to infrared range of their wavelength) with various irradiation conditions (power and scanning velocity of laser beam, frequency, laser fluence etc.).

After laser-induced surface conductivity, the effectiveness of copper electroplating will be investigated. In the electroplating system the conductive surface layer of the composite will be the cathode, while the copper plate anode, both immersed in a solution containing copper ions. The influence of the type of metallization baths (self-composed and commercial one) and voltage-current parameters on the efficiency of copper plating will be investigated. The adhesive properties of the deposited copper layers will also be determined, depending on the parameters of laser irradiation and electroplating process.

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