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. Based on a broad literature study, combination of copper fibers, copper and tin powders along with carbon black can be considered as a very promising choice of fillers for the purpose of the project. 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 infrared laser radiation (λ = 1064 nm; λ = 10.6 µm) with various irradiation conditions (power and scanning velocity of laser beam, frequency).

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.

As comprehensively analyzed based on literature review the following conclusions can be formulated:

1) Selective metallization of thermoplastic polymers can be realized by using laser direct structuring (LDS). The main problems in this method is using metalloorganics, which are not thermally stable, thus often cannot be processed with thermoplastics. Additionally, electroless metallization requires very complex metallization baths, the process itself is slow and difficult to control.
2) Electroplating metallization is simple, can be controlled by current-voltage parameters, thus even thick metallic layer can be deposited at relatively short time. However, this method requires conductive surface on thermoplastic polymer materials.
3) It is known that the commercial thermoplastic composite with the highest conductivity comprised combined metal fibers and powder. Author of this project is convinced that to increase conductivity on the all length scales of the surface area (also in the nanometer scale), also conductive nanoparticles should be incorporated into the polymer structure.
4) Thermoplastic polymers containing conductive fillers can be electroplated when reaching conductivity at least 10^{-2} S/cm. However, even then the surface is not completely covered, especially in the far most region apart from the electrode attached to the sample. In this technique all material is metalized (selective metallization is not possible, unless applying special masks).
5) Laser irradiation associated with polymer ablation can increase surface conductivity by surface carbonization, removing of polymer matric, thus uncovering metal particles.
6) Metallic fillers are resistant to laser ablation, thus its concentration during this process can increase along with depleting polymer matrix in the composite surface layer. This can lead to the significant and controlled increase in surface conductivity.

The literature review relevant to this project revealed the novelty and cognitive significance of the proposed research, which may also have a significant and measurable effects on industrial applications. Some example of this technique has been involved in rapidly developing moulded interconnect devices (3D-MID) which, in general, are an injection-moulded thermoplastic parts with structured metal traces. In these devices mechanical and electrical functions are integrated.