Titanium alloys exhibit poor wear resistance, high and unstable friction coefficient, a tendency to gall and relatively low hardness. To enhance the tribological properties of titanium alloys, a duplex surface treatment consisting of glow discharge plasma oxidation and electrophoretic deposition (EPD) of composite coatings will be conducted in the proposed project. The project is aimed at investigating suspensions stability, EPD kinetics and the deposition of low friction and wear resistant (nano)composite coatings on oxygen hardened titanium alloys, two phase (α+β) Ti-6Al-4V and near-β Ti-13Nb-13Zr, as well as an investigation of the microstructure and selected properties of materials.

Four types of composite coatings will be developed in the proposed project:
Type I: PEEK704 and PEEK708 polymer coatings (as reference materials for composite coatings),
Type II: nanocomposite PEEK704-based coatings: nc-Al_2O_3/PEEK704 and nc-Si_3N_4/PEEK704 (nc=nanocrystalline) for applications at room temperature and 37 ºC,
Type III: elevated temperature (up to 260 ºC) nanocomposite PEEK708-based coatings: nc-Al_2O_3/PEEK708 and nc-Si_3N_4/PEEK708,
Type IV: solid-lubricant coatings: PTFE/PEEK708 and MoS_2/PEEK708.

EPD kinetics and the quality of composite coatings depend on two groups of parameters (i) those related to the suspension, (ii) those related to the process, including the physical parameters, such as the electrical nature of the electrodes and the deposition conditions (potential difference, deposition time and temperature). To obtain good quality coatings, the suspensions stability used for EPD (zeta potential, electrophoretic mobility, conductivity and pH) and EPD kinetics of the co-deposition of ceramic (nano)particles (nanooxides, nanonitrides and sulfides), as well as polyetheretherketone (PEEK) and politetrafluoroetylen (PTFE) polymers, will be investigated.

The quality of the coatings will be evaluated by investigation of their adhesion to the titanium alloys, both as received and oxygen hardened, characterization of the micro/nanostructure of the materials, analysis of the surface topography of the coatings, investigation of the tribological properties (wear rate and friction coefficient), investigation of the micro-mechanical properties (hardness, Young's modulus, fatigue strength) and electrochemical corrosion resistance in Ringer's solution (coatings on Ti-13Nb-13Zr alloy) and in NaCl solution (coatings on a Ti-6Al-4V alloy). It is expected that the proposed duplex surface treatment will lead to a significant improvement in the tribological properties of the titanium alloys and increase their durability.