Since the early 50's of the twentieth century, metallic alloys like cobalt-chromium, or nickel-titanium had been commonly used as a part of medical devices, especially in implantology. However, long-term scientific researchers had shown many negative effects, i.e. corrosion or the migration of metal ions which influences on inflammation and allergies, which limit their use. Hence, in order to avoid negative effects and exploit material potential, there is ongoing scientific research designed to modify and improve their surface properties. For this purpose, polymeric materials (chitosan, PMMA, PLA) due to their similarity (physical properties) to the human tissues or ceramic phosphates (hydroxyapatite or other calcium orthophosphates) with high osseointegration properties are commonly used [1-3]. Nevertheless, their research community is constantly looking for new types of materials that can be successfully used as the coating material. In our project, we have decided to focus on two different type of materials. First are multifunctional nanocomposite consist of phosphate ceramics, designed to fulfill a scaffold for growing tissue, possess sufficient adhesion and flexibility, as well as silver nanoparticles with antibacterial features. The second type of materials is thin silica layers (type SBA-15) constructed from closely adjacent hexagonal channels with a diameter of about 4 nm. These materials, in addition to promising mechanical and physical parameters, are possible to be functionalized by bactericidal substances, such as silver ions [4-6]. As a result, our research allows for the development of a new type of coatings with long-term antibacterial effect. In addition, we plan to manufacture multifunctional system, which will combine the two above mentioned materials. Thus, silica layer will act as an interlayer providing durable chemical contact between the metallic substrate (e.g. NiTi alloy) and bioactive orthophosphate ceramic layer.

The development of the innovative bioactive composite coatings, which in the future can find a wide application in the implantology medicine, leads to being a serious technological challenge. The research aiming at the production of such coatings focus on the optimization of the technological processes and production of materials with desired physicochemical properties. The proposed project is divided into three main tasks:

(1) The chemical synthesis methods allow for the production of starting materials in the form of metallic nanomaterials (metallic silver), composite nanosystems (metal - matrix e.g. Ag/SiO_2) or phosphate ceramics (e.g. calcium orthophosphate). The composite coatings based on amorphous silica or SBA-15 silica with porous structure will be produced by the deep coating method. This allows for the production of coating with appropriate orientation of pores (perpendicular to the surface), homogeneity and thickness.

(2) The main composite coatings will be obtained with the use of sol-gel and electrophoresis methods. In both techniques the careful preparation of starting material and proper production parameter optimization is crucial. As a result, the layers with various morphology, thickness and surface parameters will be obtained.

(3) The physical properties analysis will be performed with the use of a number of techniques: the structural parameters will be obtained with the use of X-ray diffraction techniques (XRD, GIXRD) and electron transmission microscopy (TEM), the scanning electron microscopy (SEM+EDX) will be used for chemical analysis, while the photoelectron spectroscopy (XPS) will be used to determine the chemical state of selected elements. The information about the molecular arrangement, chemical bonds, and molecular interaction will be available with the use of Raman spectroscopy (RS), while the atomic force microscopy (AFM) will give information about the mechanical properties of the samples (Young modulus, adhesion). Additionally, the differential scanning calorimetry (DSC) will be used for the shape changing effect (shape - memory effect). Finally, the microbiological investigation will be performed in order to obtain the information about the antibacterial effect on various microorganisms (*Escherichia coli*, *Pseudomonas putida*, *Arthrobacter globiformis*) and cytotoxicity studies on natural dermal human fibroblast (NHDF) will be thoroughly investigated.

Summarizing, the use of innovative materials in a form of nano-sized composites and silica films with unique structure will surely advance the surface protective coating branch of knowledge. Our project will allow for the protective coating production optimization, while the obtained results will lead to the technology of durable, well attached and most important effective coating for the implantology industry.

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