The project aims to develop the completely new biomaterials in the form of bioactive coatings based on silicon oxycarbide (SiOC – the so-called black glasses) for the application as functional coatings on metallic implantable materials. We assume the preparation of glassy bioactive coatings with the pre-designed microstructure and having antibacterial properties while maintaining their cytocompatibility.

Extremely dynamic development of medicine, taking care for hygiene and change of lifestyle are causing a continuous increase of the average lifespan of a human. Consequently, the demand for the materials for bone tissue regeneration and implants with extended lifetime is constantly growing. The ideal biomaterial should possess very good biochemical and biomechanical compatibility with living tissue. One of the most interesting materials applied in the tissue engineering are bioactive glasses and glass-crystalline materials capable of permanent binding with the bone tissue and therefore in the contact with physiological fluid capable of forming carbonated hydroxyapatite (HCA) similar to the mineral phase of bones. In this way, the implanted material is fully integrated with the body. The first bioactive glass from Na_2O-CaO-P_2O_5-SiO_2 system was developed in the 1970s. However, the implants subjected to high loads could not be prepared from the bioactive silicate-phosphate glasses because they are characterized by low strength and resistance to brittle fracture. Therefore, when there is a need for carrying mechanical loads, the metallic implants (austenic steel, titanium and its alloys) providing the appropriate mechanical strength are commonly applied. Unfortunately, metals are not indifferent to the body. There is a danger that the metal ions that make up the implant will release into the blood and accumulate in organs such as the liver or lymph nodes. To prevent this process and improve the integration of the implant with the body, its surface is modified by covering it with a thin layer, for example bioactive glass. As already mentioned, typical bioglass does not create coatings with satisfactory mechanical properties. That is why we suggest using silicon oxycarbide materials, i.e. black glasses. The black glasses are glasses with the structure of amorphous silica (*v*-SiO_2) where some of oxide ions (O^{2-}) is substituted by carbon ions (C^{4-}). Such substitution leads to a local increase in the density of bonds and therefor to a significant strengthening of the network. This results in increase of mechanical strength and chemical resistance of the glass. Thus, black glasses have unique mechanical properties and are resistant to aggressive environments, and additionally can be easily formed in the form of layers on metallic surfaces. This makes them excellent candidates for use as protective, anti-corrosive layers on metallic implants. At the same time, the latest scientific research shows that black glasses, both alone and modified by the addition of calcium, magnesium or nanoparticles of bioglasses, are bioactive.

In this project, thin layers of black glasses will be obtained on steel and titanium substrates. Black glasses will be modified by the addition of phosphorus, boron, gallium, calcium, cerium, zinc and copper ions to increase the bioactivity of the starting material and give them antibacterial as well as antioxidant and neuroprotective properties.

As precursors of black glasses will be used appropriately modified ladder olio- and polysilsesquioxanes obtained by the sol-gel method. Obtained sols can easily be deposited on the metal surface by dip-coating. The layers thus obtained on metallic substrates will be subjected to thermal treatment in an inert atmosphere (pyrolysis) to carry out the ceramization process.

To be able to achieve the basic goal of the project it is necessary to precisely define the structure, microstructure and physico-chemical properties of the materials obtained. Therefore, detailed structural (MIR, Raman, MAS NMR, XPS), microstructural (SEM, AFM), chemical and mechanical resistance (nanoidentification) tests will be carried out. Correlating the results of these tests will allow to predict the final properties of the obtained layers, the most important of which are, of course - bioactivity and biocompatibility.

The assessment of bioactivity and biological properties of the materials obtained will be carried out in in vitro (Latin in glass) conditions by testing their behavior in synthetic physiological fluids and using appropriate cell lines. In this way we will get information on how the newly obtained materials will behave after implantation into the body and how the surrounding tissues will react to it. In addition, neovascularization, i.e. the material's ability to stimulate the formation of new blood vessels, will be conducted.

One of the desirable properties of the designed materials is bactericide, which ultimately helps to prevent postoperative infections. Therefore, appropriate tests will be carried out on layers containing gallium, cerium, zinc and copper ions.