The progressing climate change prompted humanity to verify its attitudes and focus its attention on issues such as healthy oceans, seas, inland waters, soil condition, and climate neutrality, generally referred to as sustainable development. We realized that technological development at the expense of clean air, drinking water, or healthy food would be pointless. Therefore, the current dominant trend is the search for modern technical solutions, new materials, and innovative processes that are neutral for the environment. Many of them are also aimed at improving the condition of the soil, water, or air. The solution proposed in this project is also in line with this trend.

The aim of the presented project is to develop a new bioactive composite coating based on silica nanostructures for environmental applications. The proposed use of silica is not accidental. Silica is one of the most abundant compounds on earth as a component of many minerals. Additionally, silica is chemically and biologically inert. For this reason, it seems to be an excellent choice as a matrix of a bioactive nanocomposite, in which copper phosphate molecules deposited on the surface of mesoporous silica play an active role. During our previous research, we have observed that the groups of copper phosphate deposited on siliceous structures may lead to the formation of biocidal or biostatic material depending on the concentration of active groups [1].

One of the factors distinguishing the proposed solution from many biocidal materials, especially those based on silver nanoparticles, is the durability of the active molecular system, the components of which do not contact directly with the bacterial cell membrane. The biocidal action is based on the formation of reactive oxygen species in the pores of silica - free radicals destroying DNA, lipid membranes, and other microbial cell fragments. This mechanism is similar to the biocidal effect of hydrogen peroxide, which involves the decomposition of hydrogen peroxide molecules, also resulting in the formation of free radicals. Therefore, it can be assumed that the coatings proposed here will show biocidal activity not only against Eacherichia coli bacteria, which was confirmed, but also against many other strains and other microorganisms such as viruses, fungi, or spores [2,3].

The bioactive coatings proposed here can be used where sterilization is impossible or difficult. Especially today, in the era of pandemics, we have become aware of the danger of high-touch surfaces as potential sources of infection. The possibility of covering high-touch surfaces such as handrails, handles, light switches, etc., with coatings that annihilate any microbes on them and prevent their multiplication would increase the comfort of using public spaces. These coatings can also find wide application in water tanks, including rainwater tanks, protecting them from the growth of unwanted algae and other microorganisms.

The main objective of the project will be the preparation of bioactive composite coatings based on mesoporous silica structures containing various concentrations of active groups, their precise characterization, examination of their biocidal activity on the widest possible spectrum of microorganisms, and testing the coating's durability on different types of surfaces (metals, glass, plastics).

An additional assumption of this project is to avoid the negative impact of proposed materials on the environment. For this purpose, a number of tests will be carried out to exclude the possibility of the release of copper ions into the environment during the use of the coating.

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