The use of nanoparticles with bioactive properties in industry is becoming dangerously widespread. Despite the enormous benefits of metal and nonmetal nanoparticles, it is risky to introduce materials into the environment without knowing what side effects they may have. Inorganic nanoparticles began to be manufactured and used in consumer products around 1980. Over the next 40 years, materials modified with nanoparticles began to be distributed in all branches of industry, in medicine, even in the food industry. It is only in the last 15 years or so that attention has been drawn to the environmental effects of nanoparticles. Unfortunately, the risks are still poorly understood. At the same time, the value of using inorganic nanoparticles as compounds with antimicrobial properties cannot be ignored. It is only necessary to limit the ability of microorganisms to develop defense mechanisms so that cells become insensitive to them over time.

The main challenge associated with the use of antimicrobials is the decline in efficacy over time due to the development of resistance in the targeted microorganisms. However, unlike conventional antimicrobials, research on bacterial resistance to nanoparticles and the mechanisms by which it occurs is limited and inconclusive. Finding a way to limit the formation of cell resistance to substances including nanoparticles could help solve many difficult questions. Is it possible to enhance the effect of nanoparticles, their penetration into the biofilm by physically weakening it by extracting its components and changing its external structure? Disrupting and weakening the biofilm structure would make cells more sensitive and susceptible to antibiotics or nanoparticles. Nanoparticles themselves show very good biocidal activity, but it is necessary to look for methods that make it difficult for microorganisms to form resistance to them.

Deep eutectic solvents (DES) have emerged as a powerful alternative to conventional organic solvents as well as to their analogues, ionic liquids. DES are commonly defined as a mixture of two or more compounds that, at a certain molar ratio, exhibit a significant reduction in melting point relative to the pure starting compounds. The main advantages over their analogous solvents are ease of preparation, lower production cost, wider choice for design purposes, and biodegradability. The fact that the individual components of DES are natural compounds makes these green solvents biodegradable, harmless and environmentally friendly.

By combining the use of the metal and nonmetal nanoparticles, confirmed as highly active antimicrobial compounds, and the natural deep eutectic solvents, which allow the extraction of micro and macro particles from biofilm, among others, it is possible to develop active multifunctional materials. The developed suspensions of metal and nonmetal nanoparticles will retain their high bioactivity against a wide range of microorganisms, and NDES, by disturbing the biofilm structure, will prevent the acquisition of cell resistance to nanoparticles.

The aim of the research is to confirm the possibility of obtaining suspensions of metal and non-metal nanoparticles with the use of natural deep eutectic solvents for complex action on microorganisms with emphasis on biofilm formation processes and analysis of formation of resistance of microorganisms to nanoparticles. The research will allow to answer the question if the presence of NDES allows to weaken the biofilm structure, enabling better penetration of nanoparticles into its interior, thus limiting the possibility of shaping the resistance to microorganisms.

The results of the project will answer the questions related to the effectiveness of the newly developed material in the fight against biofilm. The results of the research will open the way to further progress in the field of nanotechnology, with the possibility of applying metallic and non-metallic nanoparticles in natural eutectic solvents in a range of consumer and biomedical products, expanding the spectrum of new possibilities for both metal and nonmetal nanomaterials. It will also be possible to expand research into the control of harmful bacteria and biofilms.