The main idea of this project is to develop and optimize a novel method of dispersing nanoparticles of catalytically active phases, providing a new generation of structural catalysts. The project aims to create catalysts for the most important processes for pollution reduction, which include soot and greenhouse gases (CH_4, N_2O) abatement. These contaminants can be removed by their oxidation or decomposition with the help of simple chemical compounds (e.g. iron or manganese oxides). It should be stressed, that the catalysts effectiveness depends on the size of the crystallites of the active phase. In recent years the dynamically growing field of nanomaterials has provided clear evidence that the best catalytic performance is obtained for phases of nanometric sizes. Since nanoparticles have a strong tendency to agglomerate (clump into larger clusters) they must be uniformly spread and stabilized on the support materials.

The project proposes the use of microorganisms and their ability to quickly and evenly colonize the maximum available surface area, the so called „race for the surface", in order to prepare catalytic systems. Recent studies in the field of nanotechnology, nanomaterials and microbiology (interdisciplinary research) have proven that microorganisms have the ability to capture nanoparticles of specific sizes and shapes from surrounding suspensions.

Taking into account these experimental facts a novel method is proposed, in which bacteria, usually considered as harmful, will be used to selectively trap and transport nanoparticles. Forming an uniform biofilm (a group of bacteria attached to one another on a colonized surface) on the available area of catalytic filter, will evenly disperse the active phase particles. As bacteria of different strains have different sizes (100 nm – 5 μm), shapes (coccoid round, rod-shaped, filamentous, and appendaged) and surface charges they may be used as versatile carriers to settle on the surfaces of catalytic filters with different porosities. After the bacteria do their job and distribute the active phase in its given form and quantity, they can be easily removed from the catalytic system by simple calcination. The project is pioneering in its character, as in academic literature there is no information on the basic parameters concerning the capture, transport and deposition of nanoparticles by microorganisms.

The final stage of this project will be to carry out catalytic tests on the structural catalysts manufactured by the proposed method. In order to achieve the stated objectives, it is necessary to carry out interdisciplinary research, combining the synthesis of nanomaterials, their physicochemical characterization, with particular emphasis of their size and shape (using a wide range of spectroscopic and microscopic methods), examining the interaction between nanoparticles and bacteria and, finally, preparing the structural catalysts, in which the dispersion of the nanoparticles of the active phase will be carried out by bacteria.

The proposed project not only provides new, basic knowledge in the field of structural catalyst design and engineering, but also practical insights on how to produce a new generation of catalysts and, therefore, it contributes to the field of applied catalysis. In a wider perspective, the results of the research can be used for amelioration of technological processes by reducing production costs and the production of chemical waste, in line with the principles of Green Chemistry approach.