Nature is a constant source of inspiration and knowledge for modern bio–based and bio–inspired materials with unique properties. The development of such materials requires detailed knowledge of the natural structures, including their hierarchical architecture formed in the self–assembly processes.

Diatoms are one of the largest and ecologically most significant groups of organisms on Earth. They occur almost everywhere: in oceans, lakes and rivers, damp moss, rock faces. Due to their unique cell structure and morphology of silicified cell walls, diatoms have been attracting attention of the scientists for over 100 years. Despite such a long period of time, the detailed structure, the functions and possible application of their shells are still under debate.

The scientific target of this project is to provide new detailed information on the possibilities to design and manufacture of modern, advanced hybrid/composite materials with metallic matrix using a natural filler in form of diatom shells.

Diatoms shells can be used for designing micro– and nano– advanced composite materials based on their intricate architecture. The frustules can be also functionalized with the substances increasing their adhesion to the matrix, what may increase their mechanical properties. They can be viewed as "caged pores", which reduce the weight of the composite preserving its strength. It should be emphasized that they are photonic organisms – easy to culture in the laboratory and, in the future, in industrial conditions. For this reason, as a biological material for planned research, their stocks are virtually inexhaustible.

The proposed research project will provide new, in–depth insight into the structure and properties of diatoms frustules necessary to design bio-inspired hybrid/composite materials. The research will be carried out in a systematic manner, using the most modern characterization techniques: high resolution scanning electron microscopy (HRSEM), nano X–ray tomography (nano–XCT). The produced composite materials will be characterized using the aforementioned techniques as well as micro X-ray tomography (μCT) and mechanical testing. This will be possible due to the access to equipment in the leading research establishments in Europe's with the world–wide reputation.

The applicant's vision is to generate new knowledge on the structure and properties of diatoms shells and demonstrate their applicability a bio–component (filler) of innovative, bio–inspired, advanced hybrid/composite materials.