Water pollution caused by detergents, also known as surfactants, leads to the ongoing eutrophication of aquatic reservoirs. As a result of this process, the amount of water available for consumption is reduced. Surfactants are used in cleaning products, cosmetics and fertilisers. The vast number of possibilities to use detergents in industrial processes and products originate from their unique properties. However, these are synthetic compounds with long biodegradation or mineralisation. Safe, biocompatible and biodegradable alternatives must be developed immediately.

The requirements for an ideal safe surfactant are remarkable. First, they must be compounds or systems of compounds with high surface activity and foaming / emulsifying capacity, thanks to which it will be possible to create a dispersion system with the smallest possible concentration of the biosurfactant used. Second, some external factors should control their surface properties (pH, ionic strength, temperature or light). Thanks to this, foams and emulsions can undergo direct and immediate decomposition as soon as they are no longer useful in the technological process or as a cosmetic or medical agent. Thirdly, they must be hypoallergenic, biocompatible, biodegradable, and safe for humans and the environment. Fourthly, their structure and properties must guarantee easy removal from the aquatic environment, particularly from wastewater, in a mechanical or biological treatment stage. From this point of view, an ideal compound would not only easily leave the slurry by itself, but additionally, due to its properties, it should combine with other undesirable pollutants and take them with itself when leaving the sewage. It would have been impossible to meet all these requirements just a few years ago.

I want to achieve all assumed goals and develop **formulations of "smart", bio-active, surface-active and biodegradable emulsions and foams**. Obtained dispersed systems will be based on mixtures of biosurfactants with biopolymers (or nanoparticles). The additives will have bioactive, therapeutic or other properties required by the final application generated dispersed systems. To ensure the interactivity of the developed dispersed systems, I plan to introduce surfactants that change their surface activity under the influence of pH, ionic strength, temperature or light stimuli. I also want to ensure that the surfactants will interact with other biopolymers and solid particles of natural origin, complexing them and introducing them into the adsorption layer. As a result, compounds devoid of surface activity may be found in the adsorption layer in significant excess and improve the property of the thin interfacial lamella film. In the same way, the non surface-active compounds will be removed as complex additives from the wastewater slurries.

To perform these goals, I must clarify the impact of molecular structure and effects of dynamics adsorption of surfactants at different hierarchical levels of aqueous functionalised foam and emulsion from the nano to the macroscopic scale. Therefore I propose to conduct a series of tests using safe model surface-active compounds, which will interact with “smart” and natural bioactive or therapeutic biopolymers or nanoparticles.

I will study the adsorption and foam/emulsion generation properties on all levels: from molecular interactions, where adsorption layer parameters will be analysed by various tensiometers, rheometers and spectrometers (including Sum Frequency Generation spectroscopy), via thin-film rheology and stability (Thin Liquid Film Pressure Balanced Technique), till foam/emulsion structure and rheology analysis.

I want to solve the fundamental research problem regarding the impact of adsorption processes on dispersion system phase parameters and develop new and safe foams/emulsion substitutes with excellent biocompatibility and biodegradability alongside their manufacturing technologies to reduce the negative impact of traditional chemical surfactants.