Flotation is a process of selective separation of solid particles dispersed in a liquid utilising air bubbles. It is carried out in apparatus where finely ground mineral ore is dispersed in water. Gas bubbles are then dispersed in the suspension, selectively attaching to the ore particles and transporting them to the surface, where they accumulate in a froth layer removed as the process product. Flotation has found its application in various industries, including wastewater treatment, plastic recycling, and paper purification. However, it is most widely used in mineral ore processing, where it enables the separation of valuable mineral components from gangue minerals.

A key step in the flotation process is the attachment of the particle of the desired mineral component to the air bubble. In order to be able to separate the ore constituents using bubbles selectively, it is necessary to use various types of chemical reagents that affect the surface properties of the separated particles in an appropriate manner. A particularly important role, in this case, is played by collectors, i.e. substances that selectively adsorb on the surface of the desired minerals making them more hydrophobic (water-repellent). This makes them more likely to attach to gas bubbles. Surface-active compounds called surfactants are often used as collectors. Their ability to act in this manner stems from their amphiphilic nature. Amphiphilic molecules consist of two main parts: a hydrophilic (polar) head and a hydrophobic (nonpolar) tail. The hydrophilic head possesses chemical groups that enable it to bind to surfaces, while the hydrophobic tail causes the surface they accumulate on to repel water. Depending on the structure, the head of a surfactant can have a negative or positive charge. Such surfactants are referred to as anionic and cationic, respectively.

Typically, one of the mentioned surfactant types is used as a collector. However, in recent years there has been a growing number of studies showing that the simultaneous use of a mixture of both surfactants significantly improves the efficiency of the flotation process, providing a route to optimising its performance and selectivity. Unfortunately, most of these studies focus only on the final result of the process, leaving unresolved questions related to fundamental issues related to the mechanisms of particle attachment to the bubble. For the aforementioned particle attachment to a bubble to occur, the thin liquid film separating the bubble and particle during the collision, the so-called thin liquid film, must be ruptured.

This project focuses on the mechanism of stability of the thin liquid film in the presence of an anionic/cationic surfactant mixture. This research project aims to address the mechanism of thin film stability in the presence of mixed anionic/cationic surfactants. Three consecutive research tasks will be carried out to investigate and describe it. Firstly, a detailed characterisation of the effects of mixed surfactants on the surface properties of selected minerals will be carried out. Particular attention will be paid to the zeta potential of the solid (which affects, among other things, the process of surfactant accumulation on its surface) and the wettability of the surface by the liquid. Task two will investigate the interaction of a single gas bubble with a flat mineral surface in the presence of mixed surfactants. Here, an experimental setup capable of capturing the dynamic interactions between these objects will be used, allowing the stability of the thin liquid film and its leakage kinetics to be investigated. Thus, it will be possible to describe the mechanisms underlying the bubble-solid adhesion process. The final stage of the project will be to determine the influence of surfactant mixtures on the flotation process. The results obtained from the laboratory-scale flotation experiments will be correlated with the results of the earlier stages.

The results obtained during the project will allow us to deepen our knowledge in utilising the synergistic effects of surfactant mixtures in the flotation process, contributing to progress in this field. Gaining a comprehensive understanding of the potential of mixed surfactants in process intensification will facilitate improved selectivity and reduced consumption of chemical reagents, increasing the efficiency and sustainability of mineral flotation. Furthermore, the knowledge gained from this project has the potential to transcend disciplines, impacting the science of interfacial phenomena and materials engineering.