The goal of this project is to determine the effect of controlled time of adsorption of surface-active substances (SAS) at an air bubble surface on the kinetics of its attachment and three-phase contact (TPC – gas/liquid/solid) formation at a solid surface of different hydrophobicity. Kinetics of the bubble collision and the TPC formation is very important in many different processes involving multiphase flows, especially separating process, for example froth flotation. Froth flotation is a physicochemical separation technique used worldwide on a great scale to enrich ores of valuable minerals. The processes of collisions and a bubble attachment to a solid surface after the TPC formation, i.e. the fundamental steps of froth flotation, are very dynamic phenomena and occur in very short time (milliseconds). Three-phase contact is formed when a liquid (wetting) film, separating the solid and a colliding bubble surfaces, ruptures. The process of formation of the stable TPC involves three elemental stages, such as: (i) thinning of an interfacial liquid film to its characteristic critical thickness of rupture, (ii) liquid film rupture and a "hole" of the TPC formation and (iii) expansion of the TPC perimeter to prevent the bubble detachment. The stability of the wetting film is determined by the forces acting within the film, which depend on (i) state of the adsorption layer at solid and bubble surface, (ii) solution composition and solutes concentration, (iii) solid surface hydrophobic/hydrophilic properties and (iv) solid surface topography.

One of the most important factors influencing kinetics of the TPC formation, which influence also stability of wetting films, is the DAL (dynamic adsorption layer) formation over the rising bubble surface. Formation of the DAL means an establishment of motion induced uneven distribution of adsorption coverage over a moving bubble interface. The DAL formation depends on a SAS concentration and its initial adsorption coverage at the gas/liquid (detaching bubble) interface. The DAL formation causes the minimum adsorption coverage at the bubble upper (top) surface ($\Gamma_{top}$) and the maximum one at the rear surface ($\Gamma_{rear}$), i.e. $\Gamma_{top} < \Gamma_{eq} < \Gamma_{rear}$, where $\Gamma_{eq}$ is the equilibrium surface concentration over the motionless bubble. This difference in adsorption coverage causes lower velocity of the rising bubble as a result of appearance of the surface tension gradients opposing shear flow, leading to partial or full immobilization of the gas/liquid interface. Monitoring of the bubble motion parameters provides very useful information about the stages of DAL formation. For example presence of the maximum on the profiles of bubble local velocities (bubble velocity variations with distance/time) indicates that the DAL was not established yet, while the steady-state bubble motion (terminal velocity) means that the DAL is fully formed.

The initial degree of adsorption coverage over surface of the bubble detaching from the capillary orifice in SAS solutions has a significant influence on the bubble motion parameters (kinetics of the DAL formation) and kinetics of the TPC formation. The degree of initial adsorption coverage at the surface is a consequence of competition between time (rate) of the bubble growing and the kinetic of SAS adsorption. Control of adsorption coverage over the surface of a detaching bubble is very difficult, therefore there are no studies described in the literature about the influence of coverage degree on kinetics of the DAL and TPC formation. That is why the goal of this project is to carry out systematic studies to fill this knowledge gap. It will be possible, because in proposed project I plan to use a unique experimental set-up which contains an automatic programmable bubble generator with a bubble "trap". Thanks to the specially design trap the bubble can be "captured" motionless for any (precisely adjusted) time, selected on the basis of adsorption kinetics of the SAS studied. During the time of bubble residue inside the trap the gas/liquid interface can be saturated by the SAS molecules in a desired degree, and as a result, the initial adsorption coverage upon the bubble release could be precisely controlled. Moreover, the trap application will be helpful in investigations of the effect of the selected SAS chain length (with identical hydrophilic group) on the kinetics of the TPC formation on solid surfaces with different hydrophobicity with the same adsorption coverage over the colliding bubble interface. By applying the innovative research methodology, the studies planned to be carried out within the proposed project framework allow obtaining new results, never published before in the literature. Moreover, the results of the planned researches will be very helpful in the optimization of the flotation process, because, as was shown in our previous studies, there is a strong correlation between kinetics of three-phase contact formation and flotation efficiency.