Nanotechnology is young field of research, which results seems to be very interesting and promise the technological revolution. As a field of science, nanotechnology came to be when we learned how to measure and observe extremely fine objects, of size smaller than few hundreds nanometres, and began to link their unusual properties with their size. When we reduce the size of substance fragments, initially we can see no change in their physicochemical properties. However, there is a moment when mentioned properties begin to change, at first linearly and later nonlinearly. Varying quantities cover optical, fluorescent, magnetic, electric and of course chemical and biological properties. Generation and investigation of fragments of extremely fine matter has already revolutionised our science and technology and is still surprising. The products of this research are quantum dots used in electronics and diagnostics, carbon nanotubes, graphene, microchips, nanoparticles used in tumour treatment. Because of this fact, it is essential to thoroughly investigate this area. In case of gas nanobubbles, we can expect numerous interesting chemical and biological properties.

The aim of this project is to investigate the influence of physicochemical properties of liquids and process parameters on size and stability of generated nanobubbles and to propose correlations connecting these quantities with the size of generated nanobubbles. Additionally, the influence of presence of nanobubbles on change of dissolved gas concentration in liquid in time and on microorganisms as well as human and animal cells will be investigated.

Bulk nanobubbles are extremely fine (about tenths of the millionths of meter) gas balls in liquid. In contrary to their macroscale counterparts, nanobubbles are invisible to the naked eye and don't rise in liquid, floating on the same level instead. Surface tension combined with such a small size results in extremely high pressure inside the nanobubbles, what is the reason of significant increase in their density. Usage of nanodispersions was quickly adapted to various branches of industry. They are used to effectively clear surfaces (from impurities as well as microbial contaminations) without using substances toxic to human. Apart from that, they show wide usability in wastewater treatment, have positive impact on growth of both plants and animals as well as are used in fuel enrichment. Unfortunately, despite their wide usage, we lack knowledge and systematic fundamental research of their generation phenomena and their behaviour in liquid during storage. So, it is essential to investigate how to generate nanobubbles of demanded size depending on the physicochemical properties and composition (additions of salts and surfactants) of liquid phase using various generation methods. Description of the process which is acquired this way is essential to consciously control generation processes, what could result in increasing the efficiency of processes which use nanobubbles. The knowledge of the size of bubbles will allow to use oxygen nanobubbles during culturing cells which are vulnerable to hydrodynamic stress (for example human tissues or artificial organs).

During this project, we will investigate the generation of gas nanobubbles in liquid (by using porous membrane systems and electrolytical generation), stability of nanodispersions depending on the liquid phase composition. Range of the experiments will cover the influence of viscosity, density, surface tension and wettability of liquid (depending on its composition) as well as process parameters on size and surface potential of generated bubbles of various gases. To determine the stability of dispersions in stored samples, the size and surface potential of bubbles will be observed. Also, the influence of presence of various ions (pH and ion strength) and surfactants on stability of nanodispersion will be determined.

We hypothesize that, for known physicochemical properties of liquid phase, it is possible to find parameters of generation allowing to acquire stable dispersions of nanobubbles of demanded size. During this project we will try to answer the question whether the presence of nanobubbles of each gas influence viability and metabolic activity of microorganisms as well as human and animal cells. Results of this project will allow to understand the factors determining the efficiency of nanobubble generation using described systems as well as to quantify the influence of nanobubbles on the properties of the whole dispersion. It will lead to possibility of choosing proper method and generation parameters for liquids used in specific processes to acquire nanobubbles of demanded size.