The aim of the project is to develop novel methods of measurement using microfluidic systems for a slight change of physicochemical properties like the interfacial tension and the viscosity.

The viscosity and the interfacial (surface) tension are the basic parameters that characterize gases and liquids. These parameters are important in many branches of industry where fluid processing is involved and are also used in laboratory both in chemical analysis and medical diagnosis. In most cases, diagnostic tests are based on measurements of optical properties, but many chemical reactions result also in changes of the viscosity and the interfacial tension. In order to develop methods that make the possibility of accurate measuring of slight changes of the viscosity and the interfacial tension for samples with several microliters volume may start new paradigm of chemical analysis and allows to construct devices for easily detect many processes in wide application of diagnostics. The measurement of the viscosity and the interfacial tension is related to the measurement of forces and requires the use of complicated apparatus containing precise mechanical components, and for this reason, such measurements have not been used in simple tests yet. The revolutionary change in this situation is possible by using microfluidic systems. Detection of slight changes in the viscosity or the interfacial tension could be carried out in droplet microfluidic systems. Furthermore, modern microfluidic systems allow creating single droplets with a very high precision of volume and defined concentration and further manipulation on them by joining and dividing the droplets. The ability to easily automate microfluidic systems allows building a device that will execute complex algorithms in a short time, consuming small amounts of samples and reagents. This would not only mean shortening the waiting time for the result but also increase the availability of medical diagnostics in areas where access to specialized laboratories is limited.

Microfluidic systems are a network of tiny channels that liquids flow through and often have a rather complicated geometry. Their analogy can be seen in electrical circuits with both passive (resistors, capacitors) and active (transistors, logic gates, counters, etc.) components. Microfluidic systems are an integral part of more complex devices called Lab on Chip. These are miniature devices contained a whole set of laboratory functions mainly used for chemical analysis. Furthermore, These are capable of handling samples with a volume of microliters and even picoliters. Currently, intensive research is being carried out on the development and use of such devices in biology, chemistry, medicine, and industry. The project will investigate phenomena related to fluid flows in closed microfluidic systems. One of the more interesting advantages of this case study is the ability to easily implement any channel geometry. Flows bounded by walls of channels have interesting features and behaves often differently than intuition indicates. The author of this project has observed many of these intriguing phenomena by participating in research work at Institute of Fundamental Technological Research Polish Academy of Sciences. It is interesting that the phenomena occurring due to the small values of Reynolds number are repetitive and depend only on fluid properties, the preset flow rate and geometry of the microfluidic system. These unique properties will serve to develop the methods mentioned, which will be accurate, simple and inexpensive to use. The main purpose of the project is to thoroughly investigate these phenomena and to explore the possibilities of developing new methods for measuring the viscosity and the surface tension, both for immiscible and miscible liquids.