The development of materials engineering has led to the creation of new materials with improved functional properties. One of the new types of materials introduced into industrial practice are plastics and polymers. These materials exhibit the viscoelastic rheological properties, i.e., they have simultaneously properties of liquids and solids. Due to their properties such as low specific weight, high resistance to chemical agents, ease of processing, these materials are widely used in many products manufactured by the industry: e.g., chemical, automotive, aviation and space industry. In addition, these materials are widely used in everyday life.

Knowledge of rheological parameters of liquid and solid polymers is of paramount importance in the plastics industry. Accurate knowledge of these parameters determines the quality of the end products. Unfortunately, the existing mechanical methods of determining the rheological parameters of polymers (viscosity, elasticity, and density) are very cumbersome and not suitable for in-line application on the production line. Frequently used are inaccurate method of trial and error. A huge amount of processed plastics (on the order of millions of tons per year) causes that there is a pressing need to develop new rapid and reliable methods for the determination of rheological parameters of processed plastics (polymers). The current project is a response to this challenge.

It is very important both from a cognitive and practical point of view, to develop new and accurate methods of measuring the rheological parameters (viscosity elasticity and density) of plastic and polymers. New materials require new methods of measuring their rheological parameters. For the measurement of rheological parameters of viscoelastic media so far mechanical methods are used. These methods are very cumbersome, outdated, time consuming and destructive.

The scientific objective of the project is to develop theoretical foundations and creating a mathematical model of the phenomenon of propagation of transverse surface Love waves in layered viscoelastic media and on this basis to establish a new non-destructive method for the identification of rheological parameters (viscosity, elasticity and density) of viscoelastic media on the example of liquid and solid polymers . Author of the Project proposes to apply for measuring the rheological parameters of viscoelastic media a new method that uses the ultrasonic surface waves of the Love type. This will be non-destructive, rapid, accurate, computerized method without the disadvantages of classical mechanical methods.

The Project pays particular attention to the importance of transverse surface acoustic waves, i.e., Love waves in investigations of rheological parameters of viscoelastic media. Love waves are transverse surface waves which have only one component of the mechanical displacement, that performs vibrations perpendicularly to the propagation direction. For this reason, Love waves are ideally suited to study the rheological properties (e.g., viscosity, elasticity and density) of viscoelastic media.

In the theoretical part the Direct and Inverse Sturm-Liouville problems for Love waves propagating in a considered layered viscoelastic media will be formulated and solved. In the experimental part, measurements of velocity and attenuation dispersion curves of Love waves propagating in the investigated layered viscoelastic media will be performed. These measurements will be carried out in the designed and fabricated (in scope of the Project) ultrasonic research and measuring setup. The results of these measurements and developed Inverse Method will determine the rheological parameters (viscosity, elasticity and density) of the investigated viscoelastic media.

Implementation of the Project will have great cognitive importance, it will enable a better understanding of the phenomenon of propagation of the Love wave in the viscoelastic media. Developed within the Project method for identification of rheological parameters of viscoelastic media will also have large potential practical applications. It will allow the optimization of ultrasonic sensors of rheological properties of liquids, biosensors and chemosensors. Chemosensitive and biosensitive layers in ultrasonic sensors are usually made of polymers. The viscoelastic layers are also present in geological structures. Developed within the framework of the Project the theory of propagation of Love waves in viscoelastic media will allow for better interpretation of the Love wave seismograms.

Expected results of the Project will be original and will enlarge the existing state of knowledge. The results of basic research will be able to be used in the future to applied research in the field of ultrasonic sensors, in geophysics (interaction of Love waves propagating along the surface of the Earth with liquid medium, e.g., with the ocean) and in non-destructive testing (NDT). Considered within the Project problems, i.e., the theory of the Love wave interaction with a viscoelastic liquid, theory of sensors of rheological properties of viscoelastic liquids, chemo and biosensors, are still unresolved. Expected solution of these problems within the framework the Project will have a major impact on the development of such fields of science as: microelectronics, geophysics, seismology and mechanics of materials.