DESCRIPTION FOR THE GENERAL PUBLIC

Due to the possibility of tailoring properties to the needs of use, polyurethanes are utilized in many branches of industry. They are obtained on an industrial scale in the form of elastomers, thermoplastics, flexible and rigid foams, coatings or sealants, which is associated with a wide range of their functional properties. Commercially polyurethanes are obtained by polyaddition of aliphatic or aromatic di- or polyisocyanates to polyols and using low molecular weight extenders of the prepolymer chain. So far, the majority of polyurethane materials is synthesized using petrochemical (non-renewable) raw materials. In addition, isocyanates that are the main substrate for synthesis are obtained from toxic phosgene. Exposure of the human organism to phosgene as well as isocyanate may contribute to health problems. Furthermore, the by-product of the reaction for the preparation of isocyanates is hydrogen chloride, which is also toxic to living organisms and the environment. Another problem in the use of isocyanates is their high reactivity, which is associated with sensitivity to water molecules. An alternative that is part of the current trend of "green chemistry" for commercially obtained polyurethanes is the synthesis of polyurethanes by a non-isocyanate route. Non-isocyanate polyurethanes (NIPU) show increased chemical resistance, thermal stability, reduced susceptibility to hydrolysis and comparable mechanical properties compared to conventional polyurethanes. In addition, due to the still decreasing fossil-based resources and the associated price fluctuations, it is important to replace petrochemical raw materials with substrates obtained from renewable plant sources. The synthesis of polyurethanes by a non-isocyanate route can also be carried out using carbon dioxide, which contributes to the development of prospects for the utilization of this gas in organic syntheses.

The main goal of the project is to obtain new polyurethanes using the non-isocyanate method using bio-based substrates and CO_2. Polyether polyols of various molecular weights obtained from raw materials of plant origin will be used for the synthesis to define the relationship between the average molecular weight and the chemical structure, morphology and thermal, thermomechanical and mechanical properties of novel non-isocyanate polyurethanes. The used polyether polyols are obtained on an industrial scale as a result of polycondensation of 1,3-propanediol, which is obtained during the fermentation of plant sugars. In addition, in the proposed non-pressure (pressure method is usually used), the carbon dioxide will be used as the substrate, which will be incorporated into the structure of macromolecules to obtain five-membered cyclic carbonates necessary to obtain new NIPUs. In the presented project, it is proposed to obtain NIPU without using toxic organic solvents. The prepared materials will be a new class of macromolecular compounds that will be consistent with the concept of sustainable development. The scientific literature will be supplemented with new results obtained as part of the project concerning the synthesis and properties of non-isocyanate polyurethanes obtained with the use of natural substrates.

The presence of characteristic functional groups in the chemical structure of the obtained NIPU and intermediates acquired at each stage of the synthesis will be confirmed using Fourier transform infrared spectroscopy (FTIR). In addition, the chemical structure of the compounds obtained will be examined using nuclear magnetic resonance (NMR) spectroscopy and structural X-ray diffraction (XRD) spectroscopy. The morphology of the surface of polyurethane materials will be examined using a scanning electron microscope (SEM) and an atomic force microscope (AFM). Selected mechanical properties, ie tensile strength and hardness of the obtained materials, will be analyzed. Thermal stability of synthesized compounds using thermogravimetric analysis (TGA) and their thermomechanical properties through dynamic mechanical thermal analysis (DMTA) will also be determined. Based on the obtained test results, it will be possible to define the relationship between the average molecular weight of polyether polyols and the chemical structure, morphology and selected NIPU properties. The results obtained as part of the project will be the basis for further development of research and large-scale application of synthesized new non-isocyanate polyurethanes by the proposed method.