

In recent years, carbon dioxide (CO<sub>2</sub>) has become the focus of attention because of the position of CO<sub>2</sub> as the primary greenhouse gas and the implication of its emissions on the problem of climate changes. Therefore, a considerable effort has been focused over the last decades to develop a range of chemical and physical methods for efficient CO<sub>2</sub> capture and sequestration. Currently, the large-scale separation of CO<sub>2</sub> by the liquid phase amine-based absorption process is in commercial operation throughout the world. This "wet-scrubbing" CO<sub>2</sub> capture utilizes alkanolamines, such as monoethanolamine, as the solvent. During the absorption process, amine molecules in aqueous solutions react with CO<sub>2</sub> to form water soluble compounds.

An alternative to the industrial systems should be materials capable of the reversible absorption/desorption of CO<sub>2</sub> directly from ambient air. Due to the low concentration of CO<sub>2</sub> in the atmosphere (400 ppm), air capture has remained a challenge in synthetic systems. Recently there have been reports of the use for this purpose polymer containing ammonium moieties. They allow for the selective absorption of CO<sub>2</sub> from the atmosphere and are particularly attractive due to the ability to control the process of absorption/desorption on the principle of changes in humidity. The resin binds CO<sub>2</sub> in the form of bicarbonate and carbonate ions. This type of resins is particularly interesting for this project due to the presence of two components: bicarbonate ions (which are a source of carbonate bonds), and immobilized ammonium ions (which may act as catalysts of addition of CO<sub>2</sub> to epoxides).

The research on the synthesis and properties of cyclic carbonates, and their application for the synthesis of macromolecular compounds with unique physicochemical properties has been carried out in our laboratory for many years. Examples of the results of this work are: development of methods for the synthesis of oligocarbonatediols for synthesis of polyurethanes, shape memory polymers, biodegradable polymers, hyperbranched polymers as carriers of drugs and biomaterials, and non-isocyanate polyurethanes. In most of these works cyclic carbonates play an important role. They constitute a valuable source of carbonate bonds, entering the polymer chains. Therefore, there is a continuous search for new methods for their synthesis based on cheap and readily available materials.

The main aim of this project is to develop polymeric materials capable of carbon dioxide capture from atmospheric gases and converting it into useful organic molecules - cyclic carbonates. The proposed material will be capable of both: absorbing the CO<sub>2</sub> and catalysis of addition of CO<sub>2</sub> to the oxirane ring. The polymer exposed to the CO<sub>2</sub> present in the atmosphere will be capable of its temporary (reversible) binding, and then placed in a reactor in the presence of olefin oxides or other small molecules eg. halohydrines to CO<sub>2</sub> release and catalysis of the addition reaction to form the organic carbonates. Such carbonates may serve as valuable fuel additives and non-toxic solvents or be used for the synthesis of polymers having unique physical and chemical properties of great potential for medical applications.

As a platform for the synthesis of polymeric systems polyglycerols - highly branched macromolecules obtained by polymerization of glycidol or its "green" counterpart - glycerol carbonate will be used. These polymers are similar to dendrimers and are characterized by a spherical built and a large number of hydroxyl functional groups in the outer sphere of the macromolecule. They are a perfect platform for connecting various substituents which are capable of performing different functions at the same time. The functional groups responsible for the absorption of CO<sub>2</sub> and the catalysis of the addition reaction will be introduced into the structure of polyglycerol by copolymerization with appropriate monomers, or by modification of an existing polymeric matrix. The remaining hydroxyl groups will be substituted to influence the physicochemical properties of the polymeric matrix. One of the possibilities is introduction of substituents increasing the solubility of carbon dioxide in the polymer. Based on our experience from earlier research projects we have identified groups with increased affinity to carbon dioxide. It is planned to incorporate such substituents (eg. siloxane) to the structure of the multi-functional polymeric material in order to improve the diffusion of CO<sub>2</sub> into the material. All synthesized materials will be characterized in terms of structure and efficiency of absorption of CO<sub>2</sub> and the efficiency of catalysis of the reaction of preparation of cyclic carbonates.

Implementation of the project will allow the synthesis of useful chemical compounds based on easily available resources generally recognized as burdensome greenhouse gas. The scale of the potential use of the effects of the project probably will not allow for a significant reduction of pollution of the atmosphere with carbon dioxide. However, they are a step towards finding new sources of renewable materials and methods for their application.