The aim of the project is synthesis of 4,4′-azo(bis)pyridine based metal-organic frameworks (MOFs) and examination of their sorption abilities and pressure-induced effects. Experiments will be carried out in a liquid and gas environment. Comparison of results from two types of experiments will allow to broaden knowledge of materials engineering.

MOFs are crystalline polymers built of metal cations and organic linkers. Their structure resembles a cage, which may be able to capture and process other substances. MOFs are an aspiring material for industry and the chemical environment, due to their potential applications as materials for gas storage, purification, and separation, adsorbents, catalysts and drug transporters. A distinctive feature of this group of compounds is the possibility of their design, which allows obtaining materials with the desired properties. Due to the increasing concentration of carbon dioxide in the air, which is one of the most serious environmental problems in the world, the search for new technologies for effective capture, storage and utilization of CO_2 has become a global effort. The second important issue is the search for alternative fuels that will reduce environmental pollution and will be an alternative to crude oil. Currently, natural gas, consisting mainly of methane, is considered as a potential source of clean energy due to its distribution and ecology in comparison to currently used fuels. However, gas storage is quite problematic, so it is necessary to develop safe and efficient technology. Metal-organic frameworks, as materials capable of storing gases, are considered to overcome these difficulties. For this reason, research in this field is very important for the future in which greenhouse gas emissions will stop to be a global problem.

The project involves structural studies of a new metal-organic framework capable of absorbing other substances. The experiments will be carried out in gas conditions, using an improved capillary system device. A sample of the studied material will be introduced into a thin, glass tube tightly closed in one end. After the air is pumped out of the system, gas will be introduced at a certain pressure, and then an X-ray structural measurement will be performed. This measurement allows to find out the exact structure of the compounds, i.e. the types of atoms, their connections and the distance and interactions between them. A series of structural measurements will allow determining the adsorption capacity, i.e. the absorption of gases into the network. In addition, experiments will be carried out in conditions of high pressure in the liquid environment using a diamond anvil cell (DAC). Experiments using a DAC allow observation of structural changes occurring in the material under the influence of pressure. Pressure is one of the basic parameters that change the structure and properties of a substance effectively. Changes induced by pressure can affect the properties of the material, because they lead to knowledge about the behavior of materials in these conditions, discover new varieties, or receive new substances with different properties than those they have in normal conditions, which is extremely important in the food, chemical or pharmaceutical industries, as well as in geology, because many minerals were formed deep below the Earth's surface. Comparison of effects from both experiments will show the relationship between the construction and properties of new materials, which will certainly improve their design. As a result of the project will be the article in an international scientific journal, which will include the result of the research project and the obtainment of new compounds with functional properties that can be used to improve life conditions.