Heavy metals in soils pose a potential threat to living organisms and groundwater, but their long-term environmental impact has not yet been fully understood. However, it is known that heavy metals with the passage of time can be included in the food chain of both plants and animals, translating into a threat to human health and life. This is associated with the dynamic development of industrialization and heavy industry, which constantly imply an increase in the production of waste containing these metals. As a result, for several decades, new solutions and materials have been sought for solving such problems, contributing to the improvement of the quality of the environment, the comfort and quality of life on Earth. Therefore, the project's main focus is focused on the development of a new type of composites with features and properties that allow their use in environmental engineering or biotechnology. Here, it was proposed a modern solution based on the bio-perforated, mesoporous silica SBA-15 [1]. This material has a large surface area of ~ 1000 m^2/g, ensuring high reactivity in the entire volume of the molecule. At the same time, it has a number of uniaxial, ordered hexagonal channels with a diameter on their entire length of the order of 2-50 nm, providing strong capillary properties changing from the size of the channels [2]. SBA-15 is currently one of the most widely studied materials because of:

- strong adhesive and sorptive properties which are neutral for the environment and living organisms (it does not show any toxic or irritating effects, and meets the requirements of health safety),
- its physicochemical properties may be easily modified using technological processes, creating the possibility of functionalizing practically any type of functional groups with the determination of precise control of their concentration in the silica volume. This allows the development of very individual systems dedicated to specific applications.

The project assumes the use of a set of basic research to perform a full characterization of newly manufactured composite materials and to optimize the commonly used technological processes allowing to obtain such materials. Here, the project was divided into two stages:

(1) Development of the technology for the fabrication of systems based on mesoporous silica SBA-15 and activation of the structure with functional groups. At this stage, we expect that the proposed procedure will ensure the increase of sorption parameters of the product relative to traditionally used filtration systems, at the same time creating the possibility of selective uptake of heavy metals due to the specificity of silica composite. Another aim should be to optimize laboratory work procedures for the preparation of systems with varying degrees of functionalization, and a variable content of functional groups in the structure of SBA-15. This will lead to a number of composite systems, characterized by a kind of selectivity of accumulation of heavy metals and individual properties, providing strong and stable binding to the interior of the silica structure through form chemical bonds with the functional groups present in the silica structure.

(2) Physicochemical characteristics of structurally modified systems will be made taking into account the analysis of chemical composition by scanning electron microscopy (SEM), chemical environment of the individual elements by X-ray photoelectron spectroscopy (XPS), structural characterization by x-ray powder diffraction (XRD), the degree of material crystallinity and particle size by transmission electron microscopy (TEM), information about the molecular system and chemical bonding by infrared (FTIR) and Raman spectroscopy (RS). Determination of Fe concentration and on this basis calibration of the method for other metals will be done using Mössbauer spectroscopy. Aging parameters of materials or sorption parameters will be determined using X-ray fluorescence (XRF) and atomic absorption spectroscopy (AAS) methods. The polarity or porosity of the systems will be checked using the nitrogen absorption method.

The combination of knowledge and experience of people associated with various fields of knowledge has become crucial in a profound knowledge of the properties of new engineering materials, contributing also to the faster development of environmental engineering or biotechnology. We expect that in the future, new filter materials developed in the project will replace the currently used ones.

[1] *Zhao D., Huo Q., Feng J., Chmelka B. F, Stucky G. D.: Nonionic triblock and star diblock copolymer and oligomeric surfactant syntheses of highly ordered, hydrothermally stable. Mesoporous Silica Structures. J. Am. Chem. Soc. 120 (1998) 6024÷6036.*

[2] *IUPAC, 1978, Manual of symbols and terminology. Pure Appl. Chem., 31, 578*