Ever since the US President, Franklin D. Roosevelt, pronounced the famous words *"The nation that destroys its soil, destroys itself"* in 1937, this sentence has been repeated time and time again. Yet, almost a century later, the condition of this earth's most important natural resources not only did not improve, but even deteriorated significantly, and the modern world is facing an unprecedented soil crisis. Unfortunately, besides indisputable essentiality of continued fertilizers inputs to sustain food production, excessive use of such materials followed by reductions in soil organic matter, nutrients losses, fixation or volatilization, is among the major causes of soil degradation. It is therefore imperative to alleviate these adverse effects by supplementing conventional fertilization with the alternative strategies, not only fostering an improvement of nutrient use efficiency but also – providing the essential elements on the basis of plant demand.

Therefore, to take a step towards sustainable soil management, the ultimate goal of the research is to develop a formulation of slow-release SPK glass fertilizers, capable of utilizing rhizosphere natural processes to mobilize the enclosed in vitreous matrix elements.

It is not coincidental that it is precisely sulfur, phosphorus and potassium that are selected as elements participating in the formation of the spatially polymerized structure of glass fertilizers. S, P and K are considered major nutrients, and in the absence of any of them, the basic metabolic processes essential to the plant's survival are seriously distorted. Sulfur is of great importance for synthesis of proteins, functioning of certain vitamins and enzymes, not to mention its significant role in the defence of plants against stresses and pests. Meanwhile, phosphorus, being a key component of adenosine di- and triphosphates, which are the sources of energy, driving numerous chemical reactions within the plant, participates in the plant's energy transfer mechanisms, crucial to grow and reproduce. Just as important is potassium which, among others, activate numerous (even up to 60) enzymes involved in energy metabolism, takes part in neutralisation of negative charges on proteins or contributes to maintaining transmembrane voltage gradients for cytoplasmic pH homeostasis.

However, in order to meet the above-stated final goal of the research, it is of utter importance to gain a profound understanding of the mutual dependencies between the chemical composition, structure and properties of the slow-release SPK vitreous fertilizers. As soil-activity is the most prominent feature of materials of this type, their chemical composition will be selected in such a manner to enable glass dissolution under the influence of biological solutions (i.a. root exudates), while preventing its degradation in water. Of utter significance for chemical activity of designed glasses is also ensuring that obtained materials are fully amorphous and that essential macro- and microelements are introduced in the quantities adequate for plants requirements. Therefore, the preliminary investigation of as-obtained glasses will involve XRD and XRF methods for the purpose of controlling their vitreous nature and actual chemical composition, respectively. Thermal behavior of the acquired trial fertilizers, important given the parallelism between the thermal and chemical activity of such materials, will be traced by means of DSC technique. In order to control both the physical and soil-active properties of developed glasses, it is imperative to gain an in-depth understanding of the factors determining their structure. Therefore, the great part of the research will constitute comprehensive spectroscopic studies, involving Raman, FTIR, MAS-NMR, XAS methods, allowing to get an insight into the spatially polymerised framework of amorphous bodies. The assessment of the potential of the designed materials to serve as slow-release carriers of useful elements for plants would not be possible without conducting adequate experiments, verifying their soil activity. Not only then a detailed phenomenological description of SPK fertilizers' behaviour in conditions simulating root exudates will be provided, but also their chemical activity in 'real-life' field cultivations will be evaluated. These investigations will be conducted with the help of such methods, that will enable to determine if studied materials meet the requirements imposed on slow-release fertilizers (such as ICP-AES, SEM-EDS, examination of growth parameters of seedlings used in plant cultivation).

Undoubtedly, the profound analysis of the mutual dependencies between the chemical composition, structure and chemical activity of designed silicate-phosphate glasses would allow to optimize their formulation in such a manner to adjust the nutrient release-rate to local soil conditions. Ultimately, the development of the manufacturing technology for production of slow-release SPK vitreous fertilizers would aid in restoration of soil environment – the foundation of life on Earth.