Environmental contamination by different inorganic and organic substances is widely considered a problem affecting living organisms. Mycotoxins are complex organic compounds produced by fungi of different genera. They pose serious health danger even at very low concentration and most of them are highly toxic and carcinogenic. It is estimated that ~25% of all crops worldwide contain mycotoxins which can be further transferred to aquatic environments. Mineral adsorbents are easy to use and cost-effective for removal of pollutants from aqueous environments. These materials can bind hazardous substances by adsorption process. Especially clay minerals were shown to reduce toxins bioavailability. However their complete destruction is not possible by adsorption. As a results this causes secondary pollution because the mycotoxins are held by the mineral adsorbents in an unmodified form. One approach to overcome secondary pollution issue is to regenerate the used adsorbent after its use. However regeneration and reuse of adsorbents is not always possible, especially for organic pollutants. In addition some mycotoxins cannot be efficiently adsorbed due to their properties which is in particular true for deoxynivalenol (DON) and zearalenone (ZEN).

On the other hand photodegradation of targeted hazardous compounds leads to their complete destruction via redox reactions under UV/Vis radiation. For that semiconductors are used e.g. TiO_2, ZnO, CdS and g-C_3N_4. These materials when exposed to radiation generate charge carriers (electron-hole pairs) which lead to formation of reactive radicals e.g.: hydroxyl radicals (·OH) or superoxide radicals ($\cdot O_2^-$). The formed radicals further react with pollutants and cause their oxidation and subsequently complete destruction. Despite that advantage, the practical applications of pollutants photodegradation are limited due to fast recombination of charge carriers which leads to deactivation of semiconductors. One way to overcome this is the use of chemically stable and cheap supports for semiconductors. The supports provide reactive surface and lead to better dispersion of semiconductors which may increase their activity.

Clay minerals are natural and abundant layered aluminosilicates exhibiting a variety of morphologies e.g. plates to nanotubes. Especially the nanotubes are of great interest as supports in applications e.g. drug transport and catalysis. The interior of nanotubes provides confined space for diffusion of pollutants. Thus their interactions with active centers of semiconductors are stronger than on planar surfaces. It has been shown that nanotubes lead to synergistic photodegradation effects. One example are aluminosilicate imogolite nanotubes which were shown to improve photodegradation of encapsulated model pollutant – DBAN which is a polycyclic aromatic hydrocarbon (PAH).

In our earlier studies we have shown that platey kaolinite, which is the most abundant clay mineral, can be transformed into aluminosilicate nanotubes. Their formation mechanism and structural features were reported by our group. In the project we propose a methodology where kaolinite nanotubes will be impregnated by selected semiconductors to achieve high activity of the obtained materials in photodegradation of mycotoxins. Up to date scientific reports indicated the possibility of mycotoxins photodegradation. However, to our best knowledge, the research on photodegradation of mycotoxins by kaolinite-based materials is not available, especially in the form of nanotubular material. So far the materials based on kaolinite were used for photodegradation of other groups of pollutants e.g. volatile organic compounds, dyes and selected pharmaceuticals.

Based on the above considerations the following project objectives are established: (i) synthesis of aluminosilicate nanotubes from kaolinite obtained from Polish Maria III deposit - the nanotubes will play the role of nanoreactors for photodegradation of mycotoxins, (ii) synthesis of photocatalysts by impregnation of nanotubes with selected semiconductors: TiO_2, g-C_3N_4 and ZnO - for comparison a natural nanotubular mineral will be used – halloysite. The most efficient materials will be loaded with iron oxides to enable their magnetic separation from aqueous solutions, (iii) characterization of the obtained mineral materials by selected analytical methods, (iv) evaluation of the photodegradation efficiency and stability of the mineral photocatalysts in aqueous solutions containing DON and ZEN, (v) determination of photodegradation mechanisms and formed products of the reactions.

The project combines knowledge of experimental mineralogy and materials science with environmental protection. This work will be an original contribution to the development of research regarding modification and application of naturally occurring kaolin group minerals. The use of proposed mineral-based materials for photodegradation of mycotoxins will be of great importance in future applied studies concerning remediation of polluted environments.