Even though microplastic pollution has been identified in the EU as a severe threat to the environment, up until now there has been a lack of a specific comprehensive law in the EU concerning the presence and monitoring of micropollutants in the environment. From another point of view, in October 2023, the EU adopted several initiatives on microplastics and proposed a restriction of those intentionally added to products under the chemical legislation, REACH. Additionally, the EU has prepared a proposal regarding a regulation preventing pellet losses to reduce microplastic pollution. These actions indicate that EU authorities regard this problem seriously. Microplastics, with a size of less than 5 mm, can be found almost everywhere: in aquatic environments such as seas and oceans, soil, air, and animal and human bodies, where they enter through inhalation or ingestion. They can be transported for long distances, they are resistant to degradation and exhibit the potential of leaching into an aquatic environment. They may remain in the environment for hundreds of years, and the polar and deep sea environments might even prolong their presence. Moreover, an ever-increasing plastic production via many different industrial branches, their use and disposal, and also their end-of-life, result in the major emission of small degraded polymer particles into the environment causing a long-term risk to eco-systems and human health. The main source of microplastic pollution is wastewater. Consequently, sewage sludge contains microplastics which may contaminate plants and enter the food chain posing a serious risk to human and animal health. In Poland, 36.6% of sewage sludge is disposed of in agriculture (2022), where sewage sludge is used as fertilizer under strong restrictions concerning heavy metal content. This number indicates the scale of the problem. A lack of monitoring and standards for microplastic presence suggest that there is a great need for effective, and relatively inexpensive procedures for the detection and identification of microplastics in biosolids. Furthermore, this issue requires profound and detailed research. Therefore, the development of new technologies for treating biosolids, e.g. digestate from wastewater treatment plants used as fertilizer in agriculture, should also be focused on the removal or degradation of major micropollutants such as microplastics.

In recent years, the hydrothermal carbonization process has proved to be an efficient method in terms of the problematic properties of biosolids. The process is performed under temperature and pressure in an aqueous environment for a feedstock with a high moisture content (c.a. 80%) and organic origin. During the process, the water content acts as a catalyst changing the properties of sewage sludge and promoting the efficient removal of water. The temperature range of c.a. 200 °C ensures the adequate disinfection required to deactivate viruses and pathogens. The solid and liquid byproducts of this process can be used successfully as biofuels, biofertilizers and soil amendments. Regarding the presence of microplastics in hydrochar, a solid hydrothermal product, they have not, so far, been extensively studied. For that reason, research is focused on the removal and degradation of microplastics during the hydrothermal carbonization of biosolids.

The main goal of this research will be to detect and identify the presence of microplastics in hydrochar and biosolids. Therefore, the hydrothermal carbonization will be performed at temperatures of 200 and 220 °C, with residence times of 2 to 4 hours under equilibrium pressure. Next, the microplastics in biosolids and hydrothermal slurry will be extracted by using a complex long term procedure. Then, the identification of the quantity, size, shape, colour and composition of microplastics will be determined by the use of advanced instrumental techniques such as the confocal microscopy, Roman and FTIR spectroscopy, and TGA. These scientific results will enable an evaluation of the degree of the removal of microplastics by the hydrothermal method. Additionally, the impact of the main parameters of the hydrothermal carbonization process of biosolids (temperature and residence time) on the transformation mechanism of removal and degradation of microplastics will be comprehensively studied.

The research is primarily intended to broaden existing knowledge of the physical, chemical and thermal properties and dependencies between biosolids, process parameters and hydrochar in terms of the microplastic transformation during the process. Finally, an assessment concerning positive degradation and the removal of microplastics in biosolids will aid in reducing the serious ecological risk to the natural environment.