Motivation

Air quality studies in Europe have shown that, especially in eastern and central Europe, significant exceedances of air pollution standards by particulate matter (PM10 and PM2.5) are observed. According to various epidemiological studies, it is estimated that over 50,000 people in Poland die prematurely as a result of air pollution, in particular smog. The chemical composition of the solid particle fraction may vary due to the fact that it is formed as a result of industrial activities, transport, corrosion processes or the combustion of liquid or solid fuels. The inherent components of smog are various types of metallic particles, including nanoparticles, which can enter the bloodstream through the respiratory tract, inducing the formation of a number of diseases. Importantly, they are even able to cross the blood-brain barrier. Analyzes of the chemical composition of the dust fractions showed the presence of not only typical mineral fractions but also nanoparticles of metals and their oxides, including copper and zinc.

Purpose of research

The aim of this project is to determine the effect of metallic nanoparticles based on zinc and copper and their oxides on the induction of amyloidogenesis processes of selected proteins or peptides (e.g. amyloid beta peptides or human cystatin C) associated with the emergence and development of neurodegenerative diseases (Alzheimer's disease or hereditary cystatin C amyloid angiopathy). The manifestation of pathological processes occurring during the development of these diseases is the formation of amyloid deposits. We want to see what influence has the presence of nanoparticles on this process.

Description of planned research

The research planned in the project covers three main areas. In the first stage, both peptides and proteins intended for research as well as nanoparticles of copper nanoparticles, copper oxides (Cu_2O and CuO) as well as zinc and zinc oxide (ZnO) will be obtained, purified and characterized. In the next stages of the research, we want to characterize, using a combination of complementary spectroscopic, scattering and microscopic methods and using synchrotron radiation, the interactions of these nanoparticles with selected model beta amyloid peptides (with and without presence of human S100B protein) and human cystatin C. The impact of nanoparticles on the ability to create neurotoxic oligomers and fibrillar structures of the human cystatin C and Ab peptide, as well as their structure and kinetics of this process, will be investigated. The final stage of the research will be to determine the neurotoxicity of the tested nanoparticles against selected neuronal cell models, and in particular to characterize the morphological changes induced in the presence of nanoparticles.

Expected results

Understanding the process of formation and structure of neurotoxic Aβ peptide oligomers or human cystatin C and their insoluble aggregates in the presence of metallic nanoparticles (copper, copper oxides in the first and second oxidation stages and zinc) will allow to describe the neurodegenerative processes occurring as a result of environmental pollution. We hope that greater awareness of these processes will induce in the future actions to reduce the emission of this type of pollutants.