Nanotechnology (NT) is likely to have a major impact on the global economy and society in the 21st century, comparable to semiconductor technology, information technology, cellular and molecular biology. NT science and research promises breakthroughs in areas such as materials manufacturing, nanoelectronics, medicine, energy, biotechnology, and information technology. It is possible that soon NT will cause the next industrial revolution. In the NT, single molecules and atoms are manipulated. The discovery of new materials, processes and phenomena at the nanoscale, as well as the development of new experimental and theoretical research techniques will provide many advanced solutions. On the other hand, the rapid development of industry leads to environmental pollution. Heavy metal cations, such as lead(II), cadmium(II) and mercury(II), pose a serious ecological threat. Therefore, the detection and determination of ion concentrations in biological and environmental samples is of great importance. One of the useful analytical tools for this purpose are optical sensors that change their color or fluorescence intensity in the presence of a specific ion. For example, Directive (EU) 2020/2184 of the European Parliament and of the Council on the quality of water intended for human consumption indicates maximum safe concentrations of metal ions, which range from a few to several hundred micrograms per liter. Therefore, the main scientific goal of the proposed research project is to investigate a new class of colloidal solutions of nanoparticles and to study their non-linear optical properties for potential applications in metal ion detection. Two-photon excited luminescence will be used to detect metal ions. This means that instead of standard excitation of a chromophore (in this case, a nanomaterial) with harmful light in the ultraviolet range, we can excite the material with two photons in the infrared range. This process is called up-conversion energy - two-photon absorption. The advantage is that infrared radiation are not harmful to living organisms and cannot be related in any way to ultraviolet radiation - an area containing short-wavelength light, which due to high energy can damage DNA chains in cells and thus their dying. The optical effects and research techniques proposed for the measurement of metal ions will be studied by us using tunable femtosecond lasers in the range of 500 to 2000 nm. This will allow us to find the optimal region of optical radiation where the absorption of two photons can occur with greater probability. So far, such comprehensive basic research has not been conducted on a large scale. The idea of optical sensor operation is schematically presented in Figure 1. In the world of progressing miniaturization, it is not surprising that analytical methods are increasingly combined with nanotechnology, which results in the creation of nanosensors. The role of nanomaterials and NT in medical and industrial applications will play an increasingly important role day by day. The technologies used by our team to design, manufacture, modify and characterize them will, in our opinion, allow us to design materials in the nanoscale with properties impossible to obtain using hitherto known methods.

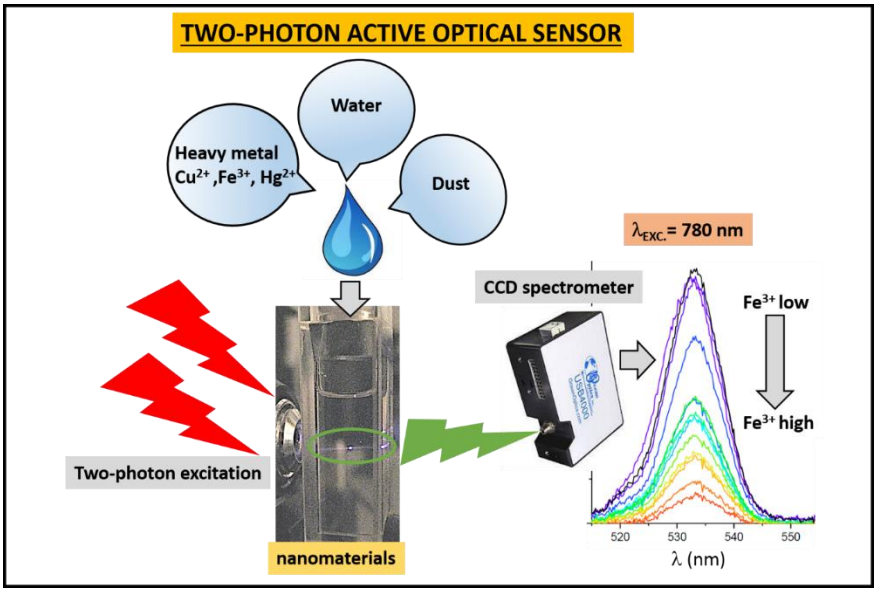

Figure 1. Scheme of operation of a metal ion sensor based on nanomaterials and the phenomenon of two-photon light absorption.