Application of an electromagnetic field-assisted hybrid photocatalytic reactor for water purification.

As the population is increasing day by day the water availability per capita is decreasing. So the main challenge of the limited amount of drinking water is water pollution that has not only environmental impact but also have a major effect on animal, human health and food production (e.g. vegetables where it is used for irrigation purpose or watering of livestock and general hygiene of the animals and equipment). According to data from the World Health Organization (WHO) lack adequate sanitation contributes about 80% of illnesses in developing countries (10% on a global scale). The appearance of microbial pollution, as a global threat, demands the development of low-cost technologies also for effective wastewater recycling. Under current legislation, recycled water can be used in food processing or as an ingredient but should be the same standard as drinking water.

In recent years, the intensification of research directed to delivery new, ecological and cost-effective methods derived to increased drinking water safety has taken place. It seems some methods fulfill above conditions. First of all, Advanced Oxidation Processes (AOPs) based on transient in situ generations of highly reactive oxidants and radicals (e.g. $OH^{\bullet}$, $O_2^{\bullet-}$, H_2O_2) which cause mineralization of organic compounds and water pathogens. Among AOPs, heterogenic photocatalysis with using titanium dioxide (TiO_2) as photocatalyst (the substance which can modify the rate of a chemical reaction using light irradiation) is most promising. Another highly developing technology is magnetic water treatment (MWT) involving magnetic separation and adsorption (using magnetic materials and nanomaterials) combine with permanent magnets (creates static magnetic field).

Introduction of mentioned methods to water and wastewater technology processes has many advantages e.g. exploitation in the ambient temperature and normal pressure (both), complete mineralization to carbon dioxide and water of organic substances and wide range of Gram-negative and Gram-positive bacteria, viruses, prions and toxins (heterogenic photocatalysis) or enhancement of aggregation of contaminants (magnetic field). Nonetheless, there are also limitations of global scale application of these processes. In particular, photocatalysis displays a better efficiency when to titanium dioxide activation very expensive UV-A lamps are used (light a wavelength from 315 to 400 nm is almost absent in solar spectrum that reaches Earth's surface), while magnetic field effect on the product yield is very slow.

We set targets to examine if it is possible to apply these processes together to water disinfection. It is evident that the implementation of magnetic field enhances some photosensitized electron transfer reactions in the presence of TiO_2 and accelerate a photocatalytic decomposition of varied organic substances. Magnetic field application also significantly influences the bacterial activity and enhances the biological treatment processes. However, the mechanisms on the involvement of magnetic field in enhancing the treatment processes are also still not completely understood and thus necessitate further investigations. The purpose of this project is to investigate the antibacterial properties of metal-doped titania exposed to Rotating Magnetic Fields (RMF) and visible light. Noble metals such as silver (Ag), platinum (Pt), in the form of nanoparticles which are a novel candidate for high absorption of visible light owing to their strong optical absorption in the entire solar region will be used to synthesis plasmonic photocatalysts. They will be compared with commercial titania photocatalysts. The construction of self-designed photocatalytic reactor assisted RMF to water purification from selected Gram negative and Gram positive pathogenic microorganisms that caused waterborne diseases will be tested. To describe the purification efficacy of RMF and titania accurate flow cytometry will be used. The laboratory-scale studies of bacteria deactivation will determine the best process parameters.