Development of civilization and industry as well as the modern way of life in developed countries contributes not only to improving people's living standards, but also leaves its mark on water environments. Special attention should be paid to estrogens which as a one of the steroid hormones have important impact on human brain, reproduction, and bone development. However, their excess can have influence for birth defects, abnormal sexual development, problems with the nervous system and the immune system, and cancer in both males and females. It was found that estrogen is one of the typical Endocrine Disrupting Compounds (EDCs) in the water environment. Despite that it is found at low concentrations in sewage they are widely studied due to their relatively high estrogen activity. Four estrogens most include three natural (17β-estradiol (E2), estrone (E1) and estriol (E3)) and one synthetic (17α-ethinyl estradiol (EE2) were found in wastewater. Significant risk to the water environment as well as on humans demonstrates especially (E2) and (EE2) which are extensively used in synthetic estrogenic medication and estrogen replacement therapy and were listed as priority substances in a proposal for an amendment of European Directives in the field of water policy. Conventional wastewater treatment methods are inadequate and they generate the problem the formation of dangerous and difficult for the utilizing intermediate products. Therefore, in recent years, New and more effective solutions for pollution removal are intensively being looked for. It is important that, new methods should be environmentally friendly and fulfills the assumption of "green chemistry". According to this, the alternative and supplementation to the classical methods became the Advanced Oxidation Processes (AOPs) including, the photocatalysis processes. Due to using natural resources such as oxygen and solar energy, photocatalysis is consider method fulfilling the assumption of the „green chemistry". Furthermore, the photocatalyst, is non-toxic. This process is based on generating of hydroxyl radicals that have the greatest oxidation-reduction potential, among known oxidants. Thanks to them, hardly biodegradable contaminants can mineralize into $CO_2$, $H_2O$. $TiO_2$ has become a promising material that is widely used in photocatalytic processes. $TiO_2$ in pure form is a non-toxic, non-corrosive, colorless solid with high chemical and physical stability. It is characterized by superior properties, such as excellent optical and electronic properties and high photocatalytic activity. In nature occurs in three polymorphic forms: anatase, rutile and brookite. During $TiO_2$ synthesis most often nanocrystalline anatase is obtained while rutile is obtained at high temperatures and it is characterized by a large size of crystallites which is disadvantageous to photocatalytic activity. The activity of $TiO_2$ materials depends on its physicochemical properties such as: specific surface area, crystalline phase, crystallite size and porous structure. It is also known that the bang gap energy value plays an important role in the photocatalysis process. This means that anatase can be only activated by radiation in the UV range, which limits its practical application. On the other hand, rutile can be activated under visible range, which would mean that it should be more active in visible light but shows much weaker activity than anatase due to faster recombination. The high temperature of rutile preparation, in turn, contributes to a decrease in the surface area of the sample.

In view of the above, the primary objective of the project is preparation and characterization of innovative nanomaterials obtained on the basis of a nanosize rutile titanium dioxide ($TiO_2$) with graphene as well as silica ($SiO_2$). It is assumed that the combination of advantages of individual compounds mentioned above will result in preparation of photocatalysts with enhanced adsorption and photoactivity in the photooxidation process of estrogens especially under Visible light. Furthermore, the advantage of modification with graphene and $SiO_2$ is that the recombination process of electron hole pairs is slowed down. An intermediate objectives of the project will be extended and systematic characterization of prepared photocatalysts as well as determine the impact modification parameters on physico-chemical as well as photocatalytic properties of new nanomaterials. An important purpose will be examined of intermediate products of decomposition and propose mechanisms of degradation. In the context of this project the photocatalytic stability of obtained materials, based on a cyclic photooxidation of estrogenes will be also determined. The one of the novelty of this work is to utilize the TRMC (Time Resolved Microwave Conductivity) studies to investigate the lifetime of charge-carriers.