

PhD thesis abstract

TiO₂/graphene nanocomposites: preparation, characterization and application of photocatalytic removal of organic pollutants from water and wastewater

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The main aim of the PhD dissertation was to prepare innovative graphene modified TiO₂-based nanomaterials active under UV and visible light irradiation, and capable of removing water and wastewater pollution. A reduced graphene oxide, produced by Polish company, was utilized as a source of graphene. All photocatalysts were prepared under elevated pressure. Thermal treatment of starting materials in the atmosphere of an inert gas was one of the most important aspects of the preparation process. This preparation step was intended to increase the crystallinity of the titanium dioxide particles. In turn, the use of reduced graphene oxide for modification of TiO₂ aimed to improve its photocatalytic activity by suppressing the electron - hole recombination process as well as improving the adsorption capacity.

All groups of prepared photocatalysts were characterized in detailed by means of different instrumental methods: X-ray diffraction (XRD), Raman spectroscopy, UV-Vis/DRS spectroscopy and scanning electron microscopy (SEM). The specific surface area and carbon content measurements as well as the zeta potential values and isoelectric point have been determined. On the basis of the obtained results, a detailed analysis of the physical and chemical properties of the obtained materials was made. The mutual dependence between particular properties and their impact on the photocatalytic activity of the obtained materials were determined. Furthermore, an important part of the study included the assessment of the preparation parameters (such as the graphene content and the annealing temperature) on the physical and chemical properties of the obtained nanomaterials.

On the basis of the obtained results, it was found that the applied TiO₂ modification methods (with or without the calcinations step) had a positive effect on the physicochemical properties of the materials. The prepared graphene modified TiO₂-based nanomaterials have revealed noticeable increase of their adsorption capacity and photocatalytic activity, determined during the photodegradation tests of various organic compounds, conducted under artificial solar light irradiation. It should be noted that the obtained photocatalysts showed increased activity towards the removal of methylene blue and acid blue alike. The increase in

activity in relation to the phenol degradation occurred only for the photocatalysts obtained via preparation method which included the calcination step. It is also worth emphasizing that in the case of photocatalysts calcined at 700-900°C, a shift of the adsorption edge towards the visible light range could be observed. This resulted in increased activity of the materials under the influence of artificial solar radiation.

14.09.18. Agnieszka Wamag