Increase of photocatalytic activity of Ag_3PO_4 by surface modification with Pt nanoparticles

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Introduction

In the recent past, pollution has become the main problem that has a negative impact on the world around us. Environmentally friendly methods and solutions that allow for removal them are intensively sought and also processes enabling to their chemical reduction by acquire alternative energy sources. One of the photocatalysts that can be used in such processes is Ag_3PO_4 . What's more, the proposed semiconductor is characterized by a narrow energy gap (2.48 eV) in contrast to TiO_2 (3.2 eV), which may indicate its high photoactivity under the influence of irradiation in the visible range (Chen, Dai, & Wang, 2015; Li, Chen, Wang, & Teng, 2014; Wan et al., 2015)(Chen et al., 2015; Wan et a., 2015; Li et al., 2014). The photocatalytic excitation mechanism can also be aided by surface modification of the semiconductor with noble metal nanoparticles. Until now, information on the application of Pt nanoparticles to the surface of Ag_3PO_4 has not been found in the literature on the subject, therefore a new modification method has been developed in this study. At the same time, the aim of the work was to assess the impact of the amount of metal deposited on the surface of the semiconductor on its properties and photocatalytic activity.

Materials and Methods

Silver phosphate was obtained in the form of two structures: a rhombic dodecahedral (hydrothermal method) and a branched form (precipitation method). Then, obtained powders were modified with Pt nanoparticles by photodeposition method (amount of Pt precursor - 0.05; 0.1; 0.5 % by weight admixture). Characteristics of the obtained powders included: morphology analysis using scanning electron microscopy (SEM), measurement of optical properties using a UV-Vis spectrophotometer, as well as photoactivity assessment in the phenol degradation process in the aqueous phase under the influence of visible irradiation ($\lambda > 420$ nm, $\lambda > 455$ nm).

Results

Based on the SEM analysis Ag_3PO_4 structures modified with Pt nanoparticles were successfully obtained. Analysis by UV-Vis spectroscopy has shown that Ag_3PO_4 semiconductors modified with Pt absorb irradiation from

the Vis range. On the basis of photocatalytic degradation of phenol, a decrease in the activity of the branched structure was observed, while for the rhombic dodecahedrals a slight increase in the rate of degradation was observed. Among all photocatalysts the highest activity in the process of phenol degradation under the influence of irradiation from the Vis ($\lambda > 455$ nm) range showed a sample with a rhombic dodecahedral structure modified Pt in an amount 0.1 and 0.5 % by weight of the admixture.

Discussion

Obtained SEM images, UV-Vis spectroscopy and measurement of photocatalytic activity confirm the success of the carried out research. Surface modification with Pt nanoparticles by photodeposition method causes increases the photocatalytic activity of Ag_3PO_4 rhombic dodecahedrals. Such a highly active compound under the influence of visible light can be used as photocatalytic material in the future e.g. to remove impurities from the environment.

References

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