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Influence of preparation method of Ag/TiO_2 composites on their photocatalytic properties

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Photocatalytic processes have drawn much attention from scientists all over the world since recent years. Ability to conduct many chemical reactions at room temperatures via different mechanisms is very promising for the development of science and industry. The most common photocatalyst to the recent time has been titanium dioxide [1], being able to effectively oxidize organic matter with the help of UV light and possessing a variety of notable advantages such as relative cheap price, lack of toxicity, and chemical stability. However, one major disadvantage of pure titania is its inability to be activated by visible light, which is more available due to its low energy and much greater presence in sunlight.

Various scientific groups have been conducting research in order to improve the activity of TiO_2 irradiated by the light of visible spectrum. Some of the known techniques are promotion by precious metal nanoparticles such as Au [2] or Ag [3], or modification of titania structure through creation of TiO_2/SiO_2 or TiO_2/CeO_2 composites [4]. In this work, promotion via metallic Ag is described, with the influence of preparation method on the resulting physical and chemical properties, such as optical absorption, catalyst structure, and photocatalytic activity being discussed.

Ag/TiO_2 photocatalysts were prepared via two different methods: impregnation in excess solution and photoreduction, with the sample series correspondingly named as Ag/TiO_2-IMP and Ag/TiO_2-PR. The support used for the deposition of Ag in both of the experiments was commercial TiO_2 Degussa P25. The amount of Ag in catalyst composition was varied.

The phase composition of the samples was investigated by X-Ray diffraction and FTIR spectroscopy. To study optical properties, UV-VIS diffuse reflectance spectroscopy was employed. To obtain metallic silver via the impregnation method, a TPR-H_2 method was also employed. Surface properties of the prepared samples were studied with the use of low-temperature N_2 method (BET). The photocatalytic activity of the samples was investigated in model experiments of Rhodamine B and methylene blue photodegradation.

According to the results obtained, the samples possess absorption in the visible range, with the impregnated titania showing broader peaks without clear signs of surface plasmon resonance. The second series prepared by photoreduction, however, does demonstrate defined SPR peaks in the range of 480-525 nm, depending on the amount of Ag. The TPR-H_2 analysis carried out for the Ag/TiO_2-IMP series indicated the reduction of Ag in the range of 110-120°C. It was shown that the highest experimental rate constant in the testing photocatalytic reaction is demonstrated by 1% Ag/TiO_2-PR, being twice as more as the rate constant of undoped TiO_2 Degussa P25. Generally, photoreduction method was shown to be superior to impregnation method for amounts of Ag less than 3% wt. during the course of RhB photodegradation experiment. However, it should be noted that the influence of Ag content on the rate constant is varied in different preparation methods. Moreover, the discussed samples showed photodegradation of methylene blue with notably different results, where the content of Ag in the system did not change the reaction rate completely. This effect might be attributed to silver leaching from the system due to the presence of sulfur-containing methylene blue degradation intermediates.

References

1. Ibhadon, A.O.; Fitzpatrick, P. *Catalysts.* **2013**, *3*, 189–218.
2. Ayati, A.; Ahmadpour, A.; Bamoharram F.F. et al. *Chemosphere*. **2014**, *107*, 163–174.
3. Jalali, S.A.H.; Allafchian, A.R.; Banifatemi, S.S. et ak.. *J. Taiwan Institute of Chem. Engineers*. **2016**, *66*, 357–362.
4. Hao, C.; Li, J.; Zhang, Z. et al. *Appl. Surf. Sci.* **2015**, *331*, 17–26.