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ABSTRACTS

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ABSTRACTS

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Synthesis and Properties of Silver-Containing Photocatalytic Systems on the Base of Titania

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1 Introduction

Photocatalytic processes have become quite actual in the recent time due to the increased interest in energy-saving technologies and effective oxidation of organic pollutants. Titania is generally considered the most popular material for photocatalysts due to its high stability, relatively cheap price and noticeably higher photoactivity [1]. Besides, the addition of small-sized silver particles to titania surface has been found to improve the photocatalytic properties of samples due to the formation of Schottky barrier responsible for lowering the rate of exciton recombination, influence on the band gap characteristics and general affinity of silver to oxidation processes [2, 3]. Moreover, the addition of silver particles to small clusters of anatase can induct a notable sensitizing effect, increasing the radiation absorbance in the visible spectrum. The purpose of the present work is to create silica-supported catalysts with anatase clusters and silver nanoparticles and to investigate the influence of the Schottky barrier on the photocatalytic properties of the prepared samples due to the electron-hole separation on the border between the metal particle and semiconductor.

2 Experimental

In the following study the samples used represent pure titania (Degussa P25), modified titania/silica and titania/alumina, with all of them also promoted with silver nanoparticles. The supported TiO_2 silica-based samples were prepared by grafting technique using tetraisopropylorthotitanate (TTIP) as a precursor, while the addition of silver was made by photoreduction [4] and impregnation methods. The amount of titania was varied approximately from 1 to 6% for the supported samples. The SiO_2 support prepared by sol-gel method was used according to [5]. All of the prepared catalysts were examined by XRD, FTIR, UV-Vis spectroscopy, TEM, AES, and Brunauer–Emmett–Teller method, also being tested in a model photocatalytic reaction, namely the degradation of methylene blue.

3 Results and discussion

The supported TiO_2/SiO_2 samples prepared by grafting have shown the presence of both anatase and amorphous titania as it is demonstrated by the results of XRD analysis. According to the FTIR data, the titanium atoms are chemically bound to the silica surface via Si-O-Ti groups. UV-Vis spectroscopy has also demonstrated a peak of plasmon resonance at ~535 nm in the silver-containing catalysts prepared by photoreduction method and a notable absorbance shift towards the UV region most probably due to the increase of the titania band gap length after the addition of silver.

The relative photocatalytic constants of the model photocatalytic reaction of methylene blue decomposition for all samples are shown in Fig. The highest photoactivity is demonstrated by the sample containing 6% wt. titania and 0.5% wt. silver added via photoreduction, most likely due to the expected effects of silver influencing on the properties of titania being an active component in the reaction. It should be also noted that unlike the $Ag/TiO_2/SiO_2$ series, the titania-silica samples without Ag don't show the same correlation of the amount of active component and photocatalytic activity. This indicates the specific behaviour of the support (silica) depending on the properties of the loaded titania and photodeposited silver particles as well. Besides, a considerably high activity is shown by one of supported silver-titania samples with the lowest amount of silver. This can be due to the specific properties of dispersed silver, like both the particle size and their shape.

It should be noted that the activity increase is observed both for unsupported and supported TiO_2 catalysts with addition of Ag. One of the reasons of this is the O^- anion radical formation on the Ag particle – TiO_2 interface border. Further work is in progress to clarify this matter.

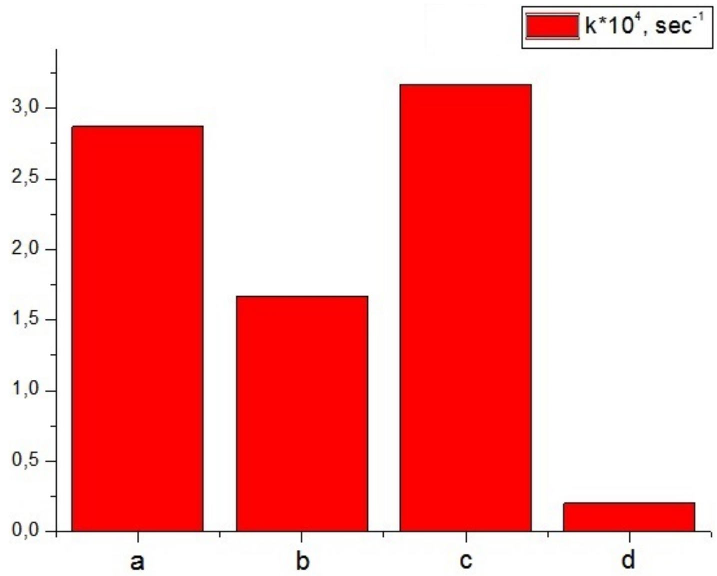

Fig. Relative constants of photocatalytic degradation of methylene blue for the tested samples: a) 0,5% Ag/TiO_2, b) 6% TiO_2/SiO_2, c) 0,5% Ag / 6% TiO_2 / SiO_2, d) TiO_2 Degussa P25.

4 Conclusions

The silver particles dispersed on the surface of both pure titania and titania/silica grafted systems do increase the photocatalytic activity of the samples, not influencing on the relative surface area.

The grafting technique responsible for the preparation of titania/silica systems also seem to increase the photocatalytic activity of the samples in the model reaction. The best photoactivity in the testing reaction is shown by **0.5 % Ag / 6% TiO_2 / SiO_2** catalyst.

Acknowledgements

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