Influence of the nature of the support on the photocatalytic activity of silver-modified catalysts for fluorescein removal and hydrogen generation in the presence of simulated solar radiation

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https://doi.org/10.65614/uisk_yucorr.2025.26.ch18

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Abstract

The growing attention to energy and environmental challenges has sparked increased interest in the development and application of clean and renewable energy sources. In particular, photocatalytic water splitting as a method for obtaining hydrogen has been highlighted as a promising alternative to fossil fuels due to its renewable and environmentally friendly nature, based on solar energy. On the other hand, the increase in industrial activity, which involves the intensive production, application, and discharge of various chemicals, often leads to significant pollution of water resources. The main challenge is how to reduce the generation and harmful effects of pollutants, so improved methods have been developed to remove certain pollutants from the aquatic environment. Organic dyes are widely used in various industrial sectors, such as textile production, the food industry, and the cosmetics and pharmaceutical sectors. It is important to note that about 10-15% of the dyes used in the dyeing process end up in wastewater, which poses a risk of pollution of aquatic ecosystems. The photocatalytic method is one of the methods for removing organic dyes and is an effective method for purifying water systems, as it manages to mineralize stable pollutants that cannot be removed by other methods. It can be applied in combination with solar radiation, which is an available and environmentally friendly source of energy. To achieve a certain efficiency in removing organic dyes, photocatalysts, which are semiconductor materials, are used. Six materials (Ag : commercial support of 2.5% (w/w)) were synthesized by the photochemical reduction method of Ag on different commercial supports. The photocatalytic efficiency of these nanopowders for hydrogen production and fluorescein removal under simulated solar irradiation was investigated. The highest efficiency in terms of hydrogen generation rate was demonstrated by Ag/TiO_2 Reaktiv (14.8 μmol/hg H_2), while the other catalysts had lower efficiency in terms of hydrogen generation rate in the time interval of 300 min. The kinetics of fluorescein removal using the above-mentioned photocatalysts was monitored photometrically. Under simulated solar irradiation, the 2.5%Ag/ZnO catalyst proved to be the most efficient, with a photodegradation efficiency of 96.9% after 120 min. The synthesized materials did not show significant fluorescein adsorption efficiency, with adsorption ranging from 0.3% for 2.5%Ag/ZnO to 24.9% for 2.5%Ag/TiO_2 Hombikat after 120 min

Acknowledgements

This study was supported by the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia (Grants No. 451-03-137/2025-03/ 200125 & 451-03-136/2025-03/ 200125). The authors are especially grateful to the Srbijagas company, which enabled the realization of this research possible by donating a gas chromatograph.