Mendeleev 2024

XIII International Conference on Chemistry
for Young Scientists

BOOK OF ABSTRACTS

St Petersburg University

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XIII International Conference on Chemistry for Young Scientists “MENDELEEV 2024”

St Petersburg, Russia
September 2-6,
2024

XIII International Conference on Chemistry for Young Scientists “MENDELEEV 2024”. St Petersburg. September 2–6, 2024. Book of abstracts.— St Petersburg.: VVM Publishing LLC, 2024.— 822 p.

ISBN 978-5-9651-1584-6

Book of abstracts contains theses of plenary, keynote, oral and poster presentations which were presented on **Mendeleev 2024**, the XIII International Conference on Chemistry for Young Scientists. The Mendeleev 2024 Conference hold in Saint Petersburg (September 2–6, 2024).

Abstracts are presented in the author's edition with minimal technical corrections.

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DISTINCTIVE FEATURES OF THE Fe_3O_4@ZnO CORE-SHELL NANOPARTICLE FORMATION, THEIR STRUCTURE AND PHOTOCATALYTIC ACTIVITY

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Currently, major cities worldwide are facing the problem of wastewater pollution by various organic contaminants. These include antibiotics and dyes, which enter water resources from light industry enterprises, livestock farms, medical facilities, and ordinary households. Current technologies do not allow for their complete elimination. Therefore, it is extremely important to find an effective and inexpensive method for treating wastewater contaminated with these pollutants.

One promising solution is the photocatalytic degradation of cyclic organic compounds under light irradiation in the presence of photocatalyst nanoparticles. However, the problem of separating water and nanoparticles in the form of powder is still present. This leads to the necessity of developing new materials that combine properties of a photocatalyst and an easily separated matrix.

Due to its non-toxicity, stability, and affordability, nano-sized ZnO is a promising candidate. On the other hand, Fe_3O_4 nanoparticles exhibit superparamagnetic behaviour, which leads to the possibility of magnetic separation. Therefore, core-shell Fe_3O_4@ZnO nanoparticles would be a promising material for wastewater treatment.

However, shell formation leads to changes in the crystalline structure and, consequently, the properties of core-shell nanoparticles. Understanding this influence and how to predict it has defined the direction of this research.

Fe_3O_4@ZnO nanoparticles with different thicknesses and crystallinity degrees of the ZnO shell were obtained. Regulation of these parameters was achieved by an original approach based on varying the synthesis temperature and the sequence of reagent introduction. The obtained samples were characterized using a complex of physicochemical methods, namely, XRD, FTIR, HRTEM, AES-ICP, XPS, Raman spectroscopy, absorption and reflection spectra, vibrational magnetometry. In addition, magnetic property modelling using the Monte Carlo method were conducted.

The comprehensive analysis of all obtained data and modelled ZFC-FC curves has revealed that the shell influences the magnetic core by forming an intermediate layer. Its structure can be represented as a sequence of "magnetite—maghemite—goethite—zinc oxide," and the composition can be varied by changing the synthesis conditions. It has been established that it is the intermediate layer that determines the magnetic behaviour of Fe_3O_4@ZnO nanoparticles.

The most effective photocatalyst in the series exhibited a naphthol green B degradation efficiency of 77% after 60 minutes of irradiation with a UV lamp. Separation using an ordinary magnet showed the same result as that using a centrifuge. Thus, Fe_3O_4@ZnO nanoparticles work as a promising photocatalyst that can be easily separated using an inexpensive method.

Acknowledgements

This work was supported by the Russian Science Foundation (project No. 23-23-00220). Scientific research was performed at the research park of St. Petersburg State University: Centre for X-ray Diffraction Studies, Centre for Innovative Technologies of Composite Nanomaterials, Chemical Analysis and Materials Research Centre, Centre for Physical Methods of Surface Investigation, Centre for Optical and Laser Materials Research, Interdisciplinary Resource Centre for Nanotechnology.