Proceedings of the 4th World Congress on Recent Advances in Nanotechnology (RAN'19)
Rome, Italy – April, 2019
Paper No. ICNNFC 130
DOI: 10.11159/icnnfc19.130

Reduction of Methylene Blue, Methyl Orange and 4-Nitrophenol Using Ag Nanoparticles

Adrian Radoń[1], Rafał Babilas[1], Dariusz Łukowiec[1]
[1]Faculty of Mechanical Engineering, Silesian University of Technology
Konarskiego 18 a St., Gliwice, Poland
adrian.radon@polsl.pl; rafal.babilas@polsl.pl; dariusz.lukowiec@polsl.pl

Extended Abstract

The catalytic reduction of different dyes such as methylene blue by silver nanoparticles (Ag NPs) and gold nanoparticles (Au NPs) was studied in literature [1]. It was previously shown, that Ag and Au NPs can accelerate the reduction process, which is associated with electron transfer from $NaBH_4$ into, for example, methylene blue molecules. Additionally, many different methods of synthesis, such as simple chemical reduction and biosynthesis were proposed previously [1], [2]. The biggest challenge is currently synthesis of pure Ag NPs by simple and low cost method, which can be used in industry.

In this study silver nanoparticles were synthesized by simple and low cost UV-irradiation method using chloramine T as new organic modifier. The prepared nanoparticles were collected by centrifugation and washed two times by deionized water, ethanol and acetone; dried at 55°C. The catalytic activity and optical properties were determined for aqueous solutions. For this purpose, stable 2 mM solutions were prepared. The analysis of morphology and structure of Ag NPs was performed by using transmission electron microscope and X-ray diffraction method. Two drops of dispersion of Ag NPs in ethanol were placed on a copper mesh with carbon film and analysis was performed for these samples. It was confirmed, that the pure, silver nanoparticles can be synthesized by proposed method as well as nanoparticles encapsulated by chloramine T. Formation of these nanoparticles is preceded by the formation of clusters of silver atoms, which was also observed during the analysis of STEM and HRTEM images. The catalytic activity of synthesized nanoparticles was assessed against toxic dyes (methylene blue and methyl orange) and 4-nitrophenol. The reduction of tested chemical compounds was monitored at regular time interval using UV-Vis spectrophotometer. The experiment was carried out at ambient temperature. To determine catalytic activity of synthesized nanoparticles the dyes degradation percentages were calculated (as well as a rate of the catalytic activity using Langmuir-Hinshelwood equation) according to Ref. [3].

It was confirmed, that the synthesized nanoparticles can be used to reduce different dyes and 4-nitrophenol. It has been previously reported, that addition of Ag NPs increases the ratio of reduction of methylene blue and the catalytic activity is associated with the particle size. It was shown, that nanoparticles with smaller size having higher reaction rate, which was also confirmed in this study [1], [4]. It was noted that the rate constant over the total weight of the catalyst was equal to 8.34 $g^{-1}s^{-1}$, which is significantly high in comparison with the literature data. This high catalytic activity was related to the defects on the surface of Ag NPs.

References

[1] V. S. Suvith and D. Philip, "Catalytic degradation of methylene blue using biosynthesized gold and silver nanoparticles," *Spectrochim. Acta - Part A Mol. Biomol. Spectrosc.*, vol. 118, pp. 526-532, 2014.
[2] M. Vanaja *et al.*, "Degradation of methylene blue using biologically synthesized silver nanoparticles," *Bioinorg. Chem. Appl.*, vol. 2014, 8 pages, 2014.
[3] E. R. León, E. L. Rodríguez, C. R. Beas, G. Plascencia-Villa, and R. A. I. Palomares, "Study of Methylene Blue Degradation by Gold Nanoparticles Synthesized within Natural Zeolites," *J. Nanomater.*, vol. 2016, 10 pages, 2016.
[4] J. Saha, A. Begum, A. Mukherjee, and S. Kumar, "A novel green synthesis of silver nanoparticles and their catalytic action in reduction of Methylene Blue dye," *Sustain. Environ. Res.*, vol. 27, no. 5, pp. 245-250, 2017.