ID: 4029

Co-Precipitation Synthesis and Characterization of the Sillenite $Bi_{12}CoO_{20}$ for the Degradation of a Pharmaceutical Product in Aqueous Solution

Madji Sérine[1*], Belmedani Mouhamed[1], Mekatel El Hadj[1], Vieillard Julien[2]

[1]Laboratory of transfer phenomena, Faculty of Mechanical and Process Engineering (USTHB), El-Alia, Algeria
[2]Normandie University, ROUEN, CNRS, COBRA (UMR 6014), 55 rue Saint Cermain, France
*Corresponding author's email: serine.madji@gmail.com

ABSTRACT

This study aims to synthesize a high photocatalytic performance semiconductor for the removal of a pharmaceutical pollutant namely Amoxil (AMX); the new heterojunction photo-catalyst $Bi_{12}CoO_{20}$/ZnO was used for this purpose. The sillenite $Bi_{12}CoO_{20}$ (BCO) was synthesized by co-precipitation and characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM) and dynamic light scattering (DLS). The photocatalytic activity has been assessed for the AMX degradation, and optimized with respect to the pH (3 - 9) and catalyst dose (0.25 - 1.25 g L^{-1}).

Keywords: co-precipitation, Amoxil, $Bi_{12}CoO_{20}$/ZnO, photodegradation.

1 Introduction

Water pollution is caused by various sources and discharge (dyes, pharmaceuticals, pesticides, heavy metals, etc.) are responsible for the degradation of water quality with the adverse consequences for humans, wildlife and plants. Many pharmaceuticals are not adsorbed by the subsoil due to their polar nature, and can therefore end up in drinking water [1]. Compared to other pharmacological categories, antibiotics are a major problem, as they are the most used and their existence can increase aquatic toxicity [2]. Therefore, treating pollution and improving water purification techniques are urgent solutions to deal with this problem. In this respect, the Advanced Oxidation Processes (AOPs) are attractive for the mineralization of non-biodegradable substances [3]. Among AOPs, heterogeneous photocatalysis is an efficient and inexpensive strategy for the elimination of liquid effluents since it uses solar energy and does not contain by-products harmful to the environment [4]. . This research is devoted to the heterojunction BCO/ZnO for the wastewater treatment from pharmaceutical industries. Bi-based semiconductors are topical materials due to their photocatalytic performance in environmental pollution control. Amoxil (AMX), a typical bacteriolytic antibiotic was chosen to evaluate the photocatalysis of this heterojunction.

2 Experimental

2.1 Synthesis of $Bi_{12}CoO_{20}$

The BCO catalyst was synthesized by the co-precipitation from stoichiometric amounts of bismuth nitrate Bi(NO3)3.5H2O and cobalt chloride CoCl2.6H2O. Then, NaOH was added dropwise until pH 12 and the solution was left 24 h for the precipitation. The precipitate was washed with distilled until reaching pH ~ 7, the gel was filtered and then dried at 80 °C for 12 h. The obtained powder was crushed and then burned at 300 °C. The powder was sintered at 750 °C for (4 h) in air oven. Once the catalyst was synthesised, the Bi12CoO20/ZnO heterojunction was prepared with 75% BCO and 25% ZnO.

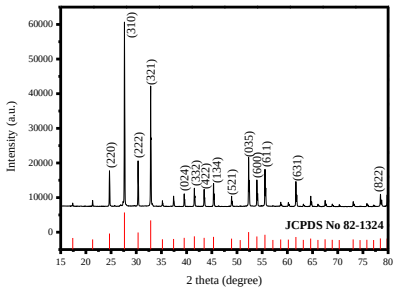
3 Results and Discussion

3.1 BCO characterization results

The identification of the synthetized phases and their structural characterization were examined by XRD analysis. The diffractogram of the Sillenite BCO (Fig. 1) shows narrow peaks characteristic of a good

DOI: 10.21467/abstracts.170 ISBN: 978-81-970666-1-0 (eBook)

crystallization and indexed in a cubic symmetry, (space group I23: N°197) the refined lattice constant was discovered to be 10.1900A° according to the JCPDS card PDE No 82-1324 (figure 1). The SEM analysis was used to examine the morphology of the powder and to evaluate the grains size of the sellinite. The study was performed with a magnification of 10 µm with a particles size of 1.5 µm (figure 2). Dynamic light scattering (DLS) was used to confirm the particle size of Bi12CoO20.



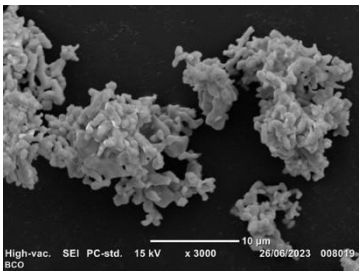
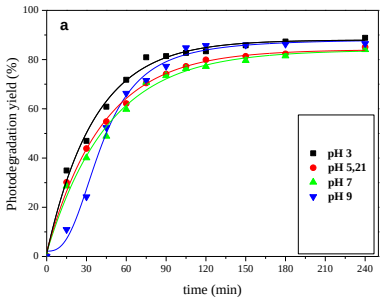


Figure 1: X-ray pattern of the Bi_{12} Co O_2

Figure 2: SEM image of synthesized BCO nanoparticles

3.2 Effect of pH and catalyst dose

Figure 3 indicates a maximum AMX removal at an acidic (pH 3) with an abetment of 87.5% and decreases with augmenting pH to 9 where the percentages do not change significantly. As expected, the AMX oxidation increases with increasing the catalyst dose (Figure 4) to reach a maximum of 85% for a dose of 1 g L^{-1}. This is due to the increased number of photo-catalytic sites on the sensitizer BCO with a larger reception surface for incident photons, leading to a higher concentration of free reactive radicals O_2 ⁻ and OH responsible of the AMX oxidation.



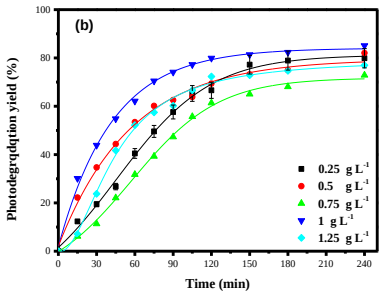


Figure 3: effect of pH at C_o = 10 mg L^{-1} and

Figure 4: effect of the catalyst dose at pH 5.2

4 Conclusions

The parametric study of the photo-catalytic degradation of AMX in the presence of the BCO/ZnO heterosystem enabled us to optimize the best operating conditions for the best removal efficiency of this pollutant. Better degradation was detected at pH 5.2, a dose of 1 g.L-1 and a concentration of 10 ppm, with a yield of 85% in just 180 min.

5 Acknowledgements

I would like to thank the entire Cryoprocess Energy Environment team for their help and support in making this work possible.

References

[1] A. Tab, M. Dahmane, C. Belabed, B. Bellal, C. Richard, and M. Trari, Sci. Total Environ. **780**, 146451 (2021).
[2 K. Laloučková and E. Skřivanová, Sci. Agric. Bohem. **50**, 15 (2019).
[3] C. Reyes, J. Fernández, J. Freer, M. A. Mondaca, C. Zaror, S. Malato, and H. D. Mansilla, J. Photochem. Photobiol. Chem. **184**, 141 (2006)
[4] H. Kenfoud, O. Baaloudj, N. Nasrallah, R. Bagtache, A. A. Assadi, and M. Trari, J. Mater. Sci. Mater. Electron. **32**, 16411 (2021)

ISBN: 978-81-970666-1-0
Series: AIJR Abstracts
DOI: 10.21467/abstracts.170