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# Photocatalytic decolouration, degradation and disinfection capability of $Ag_2CO_3$/ZnO in natural sunlight

Leena V. Bora [a,*], Rajubhai K. Mewada [b]

[a] Department of Chemical Engineering, Institute of Technology, Nirma University, Sarkhej-Gandhinagar Highway, Ahmedabad, 382481, India
[b] Department of Chemical Engineering, LE College, Near Natraj Fatak, Morbi, 363642, India

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ABSTRACT

In this study, a series of hybrid $Ag_2CO_3$/ZnO composites were synthesised via a simple precipitation route and investigated for discolouration-degradation of Methylene Blue and disinfection of *Escherichia coli* in natural sunlight. It was observed that the photonic efficiency of discolouration was more than 6 times that of the conventionally popular $TiO_2$, under experimental conditions; 100% Total Organic Carbon reduction was observed in 30 min and 32% disinfection in an hour. This upswing in the performance is attributed to favourable modulation of the dynamics of charge transfer. The photocatalysts were characterized by X-Ray Diffraction, Scanning Electron Microscopy, Transmission Electron Microscopy, Brunauer, Emmett and Teller and Ultraviolet–Visible-Near-InfraRed Spectroscopy. An equitable photocatalyst functional mechanism has also been proposed on the basis of Tauc plot and scavenging experiments. The effect of influencing parameters has also been investigated and reported in terms of photonic efficiency. Since the entire study is carried out in direct sunlight, it inherently supports realizable solar energy applications in wastewater treatment.

## 1. Introduction

In order to curb water pollution, it is necessary to treat the industrial effluent before it is discharged to natural water bodies. Conventional treatment methods, generally, only transfer the pollutant from one phase to another, without actually degrading them. Solar photocatalysis, however, is capable of completely degrading the pollutant into $CO_2$ and water using sunlight.

The conventionally popular $TiO_2$ photocatalyst is able to utilise only the UV region (approx. 4%) of the solar spectrum. Photocatalysts working in the visible region (approx. 47%) undergo a major drawback of recombination of the photogenerated electrons and holes due to low bandgap. To be able to utilise the visible region more effectively, a plausible approach is to manipulate the charge dynamics by coaxing the $e^-$ and $h^+$ on to the surfaces of binary or ternary photocatalyst composites [1–6].

$Ag_2CO_3$ and ZnO are two such photocatalysts that have been studied by several researchers [7–15]. Combining them together in order to form an $Ag_2CO_3$/ZnO binary composite is also reported. However, an artificial source of light (UV + Visible) was used during the reported investigation. Wu et al. [16] investigated its performance on Rhodamine 6G under irradiation by a 1000 W Xe lamp ($\lambda$ >420 nm); Xiang et al. [17] under simulated light over Rhodamine B, Golzad-Nonakaran et al. [18] using a 50 W LED source for illumination, etc. The combination of $Ag_2CO_3$ and ZnO has not been reported for dye degradation using natural solar light under actual day conditions. The present work is aimed to investigate the discolouration, degradation and disinfection efficacy of $Ag_2CO_3$/ZnO composite under natural sunlight. Hence this work can be utilised for industrial wastewater treatment using direct solar energy, hence would be more economical and relevant to industrial applications. The effect of operational parameters has been discussed here in terms of Photonic Efficiency. The results are reported as an average of three experimental values and represented with appropriate error bars.

## 2. Experimental

### 2.1. Preparation of the photocatalyst

99.9% pure zinc oxide (Mol. Wt. 81.41) powder was used as-purchased. Similarly, anatase $TiO_2$ (Mol. Wt. 79.87) was used as-purchased only for a comparative study. The preparation method is depicted in Supplementary Fig. 1 and explained here in detail. $Ag_2CO_3$ was prepared via ion-exchange method as described in our previous work [19].

* Corresponding author.
*E-mail address:* leena.bora@nirmauni.ac.in (L.V. Bora).

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