2024 ENGINEERING INSTITUTION OF ZAMBIA SYMPOSIUM

SYNTHESIS AND APPLICATION OF ZnO NANOPARTICLES FOR PHOTOCATALYTIC TREATMENT OF WASTEWATER

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Avani Victoria Falls Resort, Livingstone, Zambia

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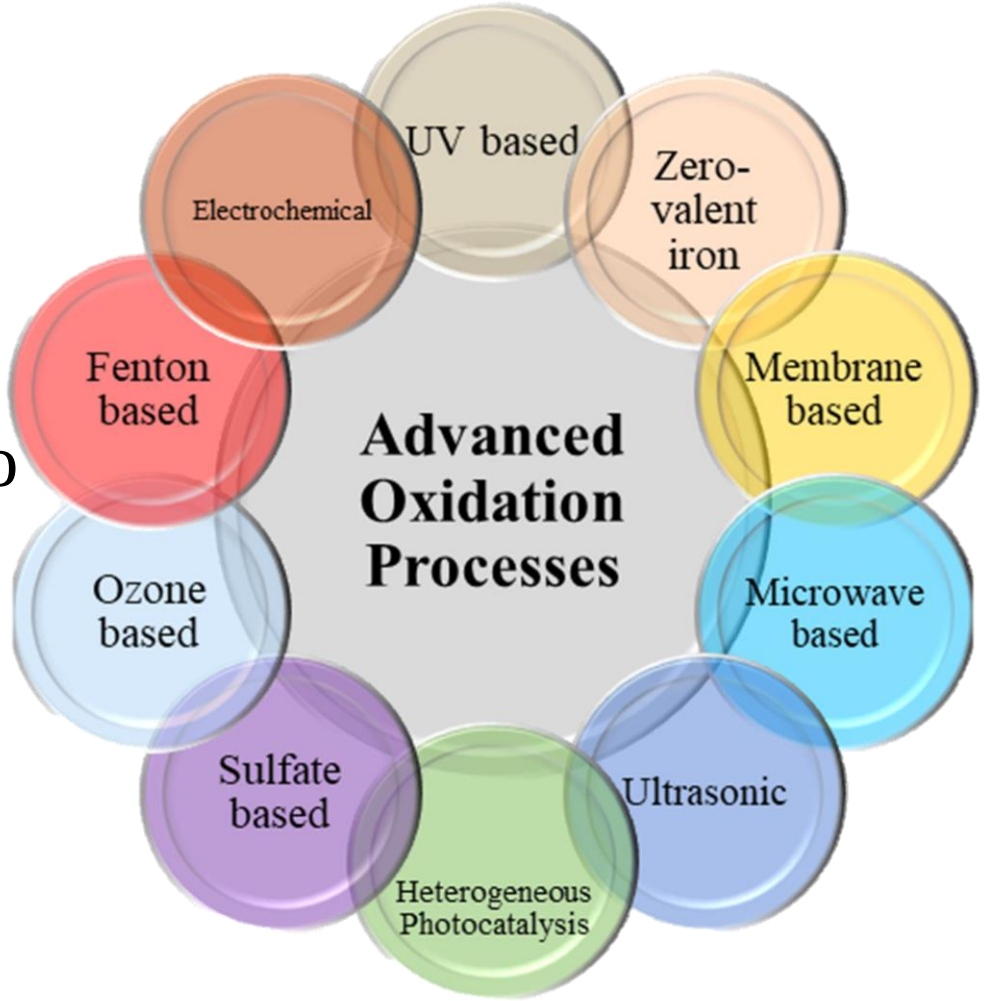
Introduction

- Pollution of the marine environment by textile effluents has become an exponentially growing problem as the need for textile products continues to rise.
- One of the major constituents of textile effluents is **DYE COMPOUNDS.**

- In large quantities and high concentrations; coupled with their recalcitrant nature, these dye compounds cannot be efficiently treated using currently existing conventional techniques.
- Moreover, these dye components can present as toxic to humans, plants and marine life.

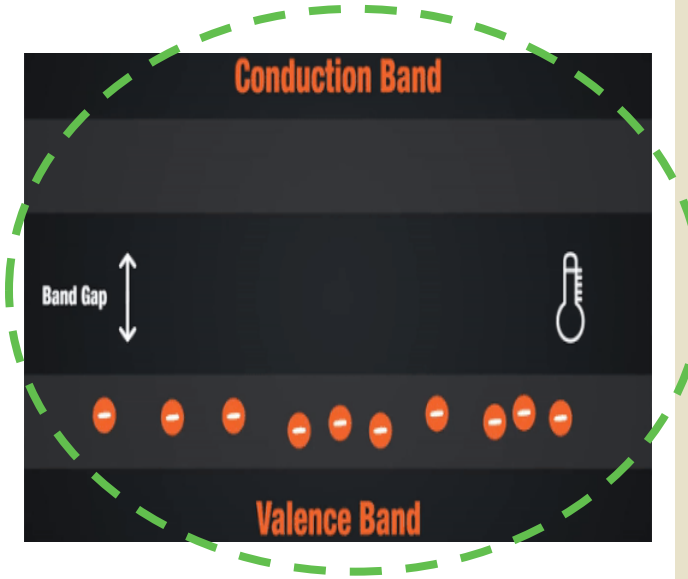
Introduction Cont'd

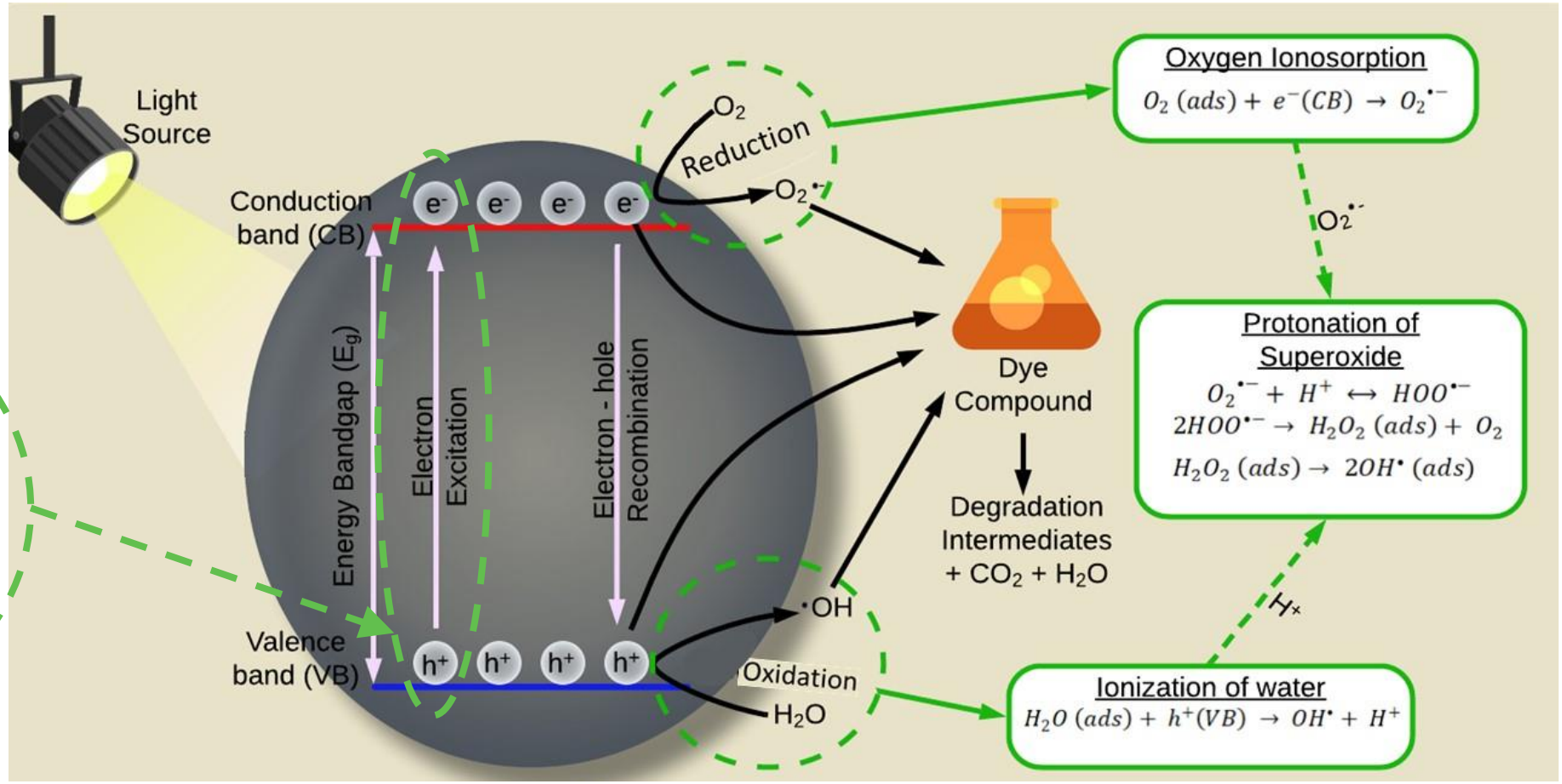
- As a result of this toxicity, there is a significant necessity to explore more efficient approaches to treating these colored effluents before releasing them into the environment.
- Advanced oxidation processes (AOPs) are one such approach that is being studied for its capability to completely degrade toxic pollutants such as dyes.



- The photocatalytic degradation mechanism (PDM) has been identified as a cost-effective and highly efficient AOP, demonstrating significant effectiveness even under natural light conditions.

Introduction Cont'd



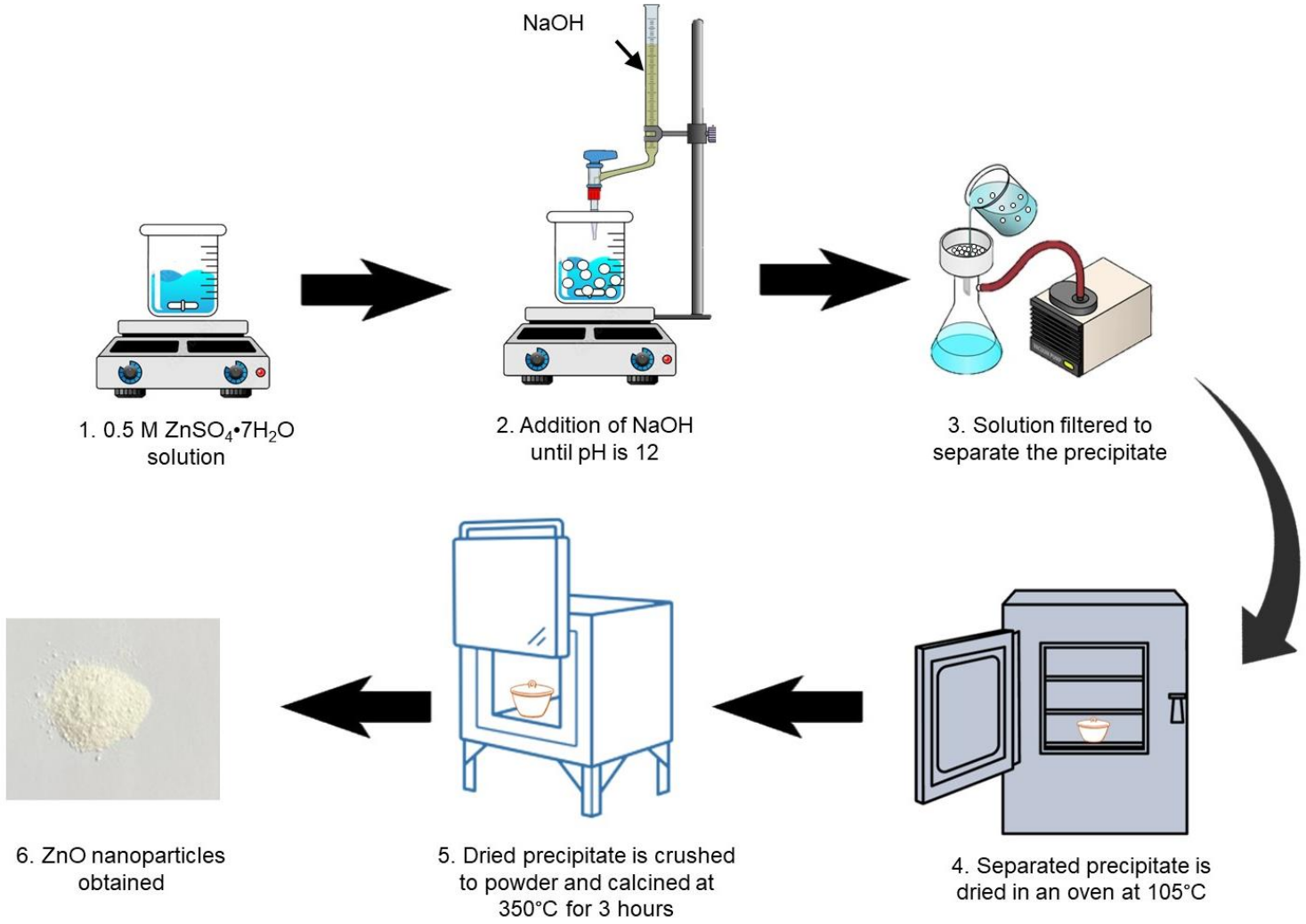


Introduction Cont'd

- In this work, we synthesized ZnO nanoparticles using a simple co-precipitation technique and applied them for photodegradation of wastewater containing Methylene Blue Dye (MB).

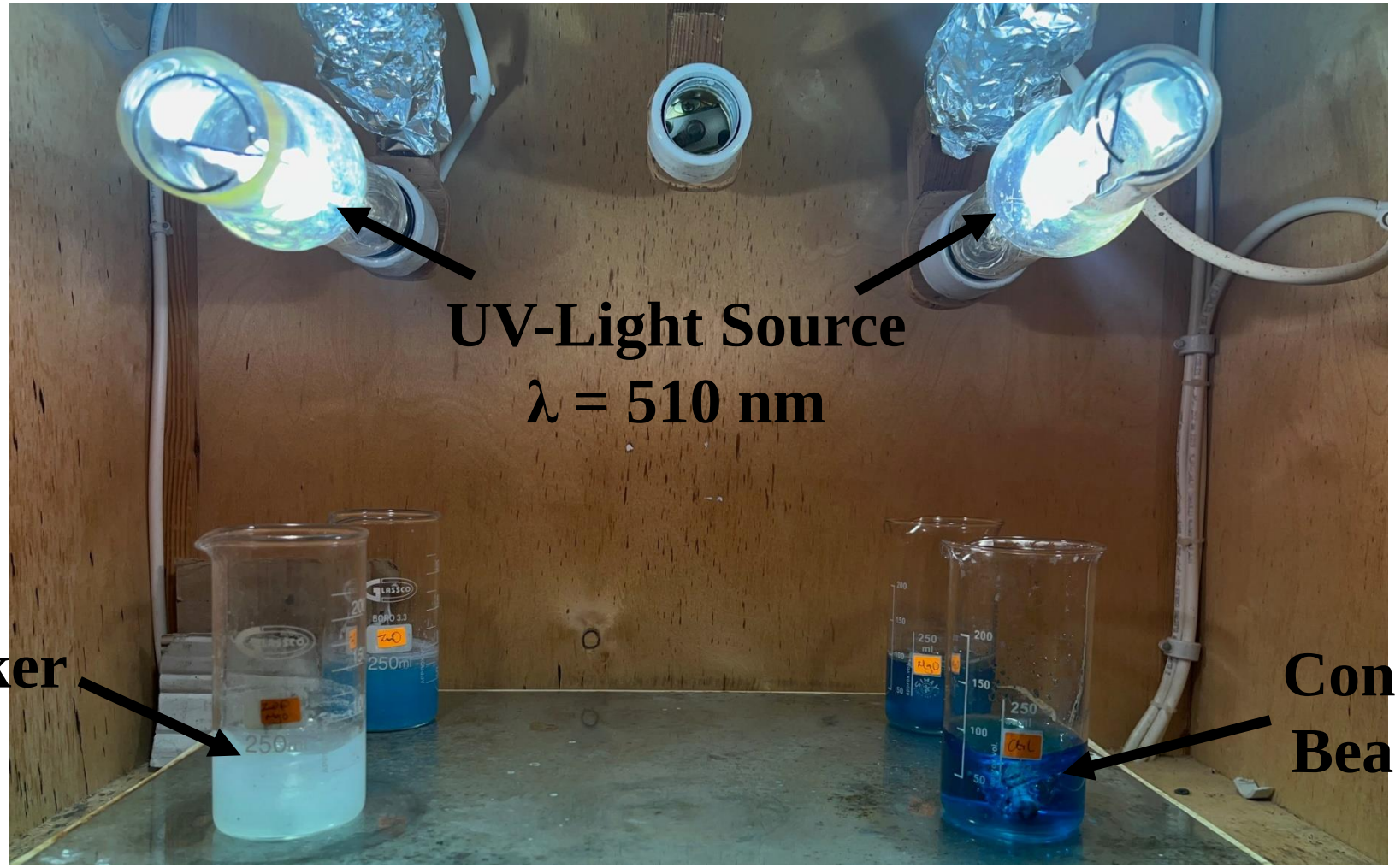
Experimental Methods

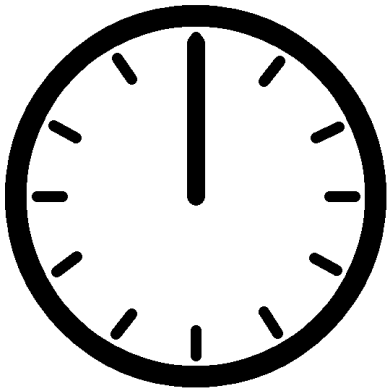
- Catalyst Synthesis



Experimental Methods Cont'd

- Catalyst Testing





3 Hours

Analytical Methods

- Material Characterization

(a) X-Ray Diffraction Analysis (XRD)

(b) Fourier-Transform Infrared spectroscopy (FTIR)

(c) UV-vis Diffuse Reflectance Spectroscopy (UV-vis DRS)

(d) Transmission Electron Microscopy (TEM)

(e) Particle Size Distribution

Results and Discussion

- Material Characterization

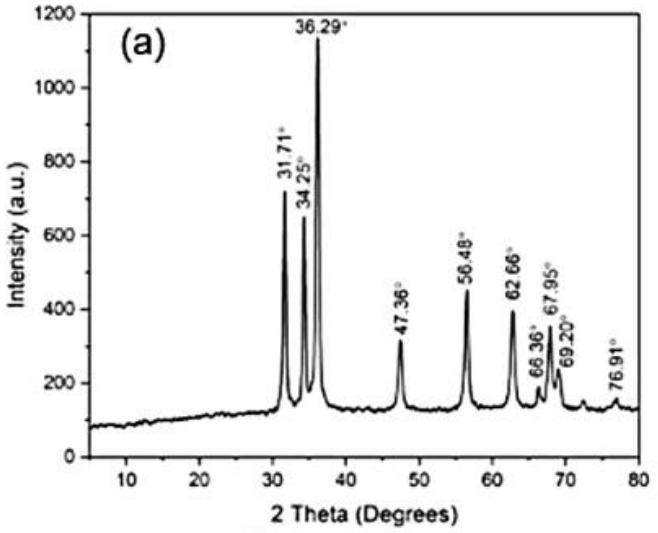
(a) XRD Analysis

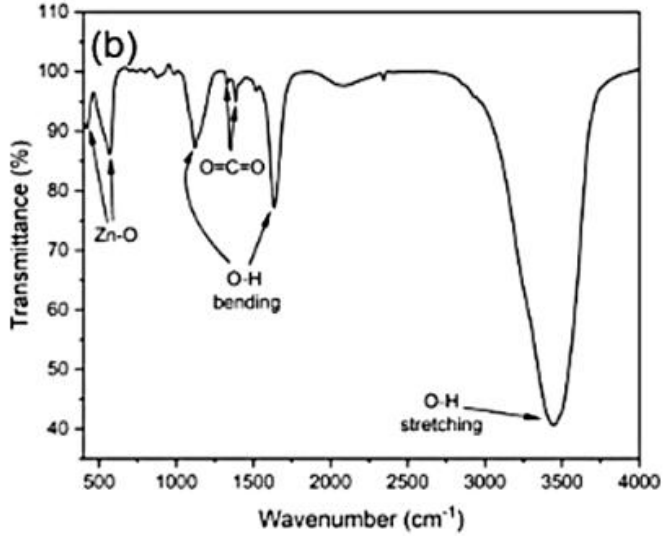
(b) FTIR Analysis

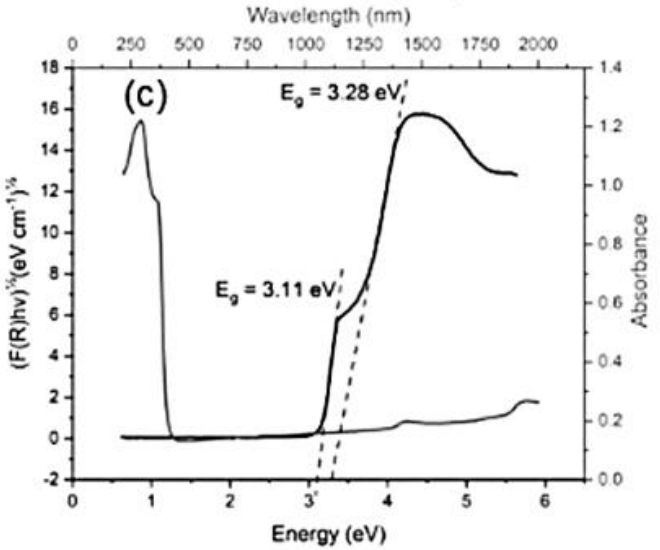
(c) UV-vis DRS Analysis

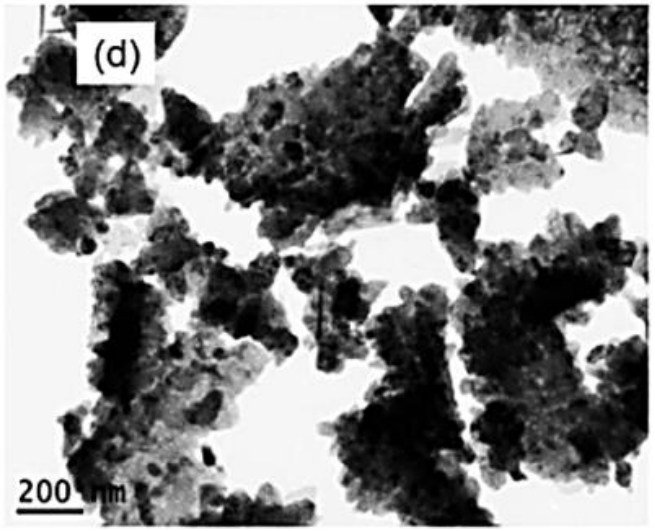
(d) TEM Analysis

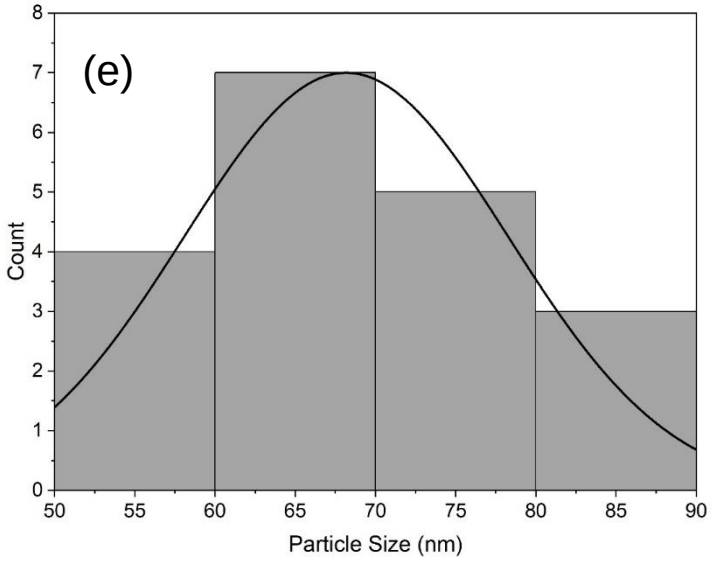
(e) Particle Size Distribution





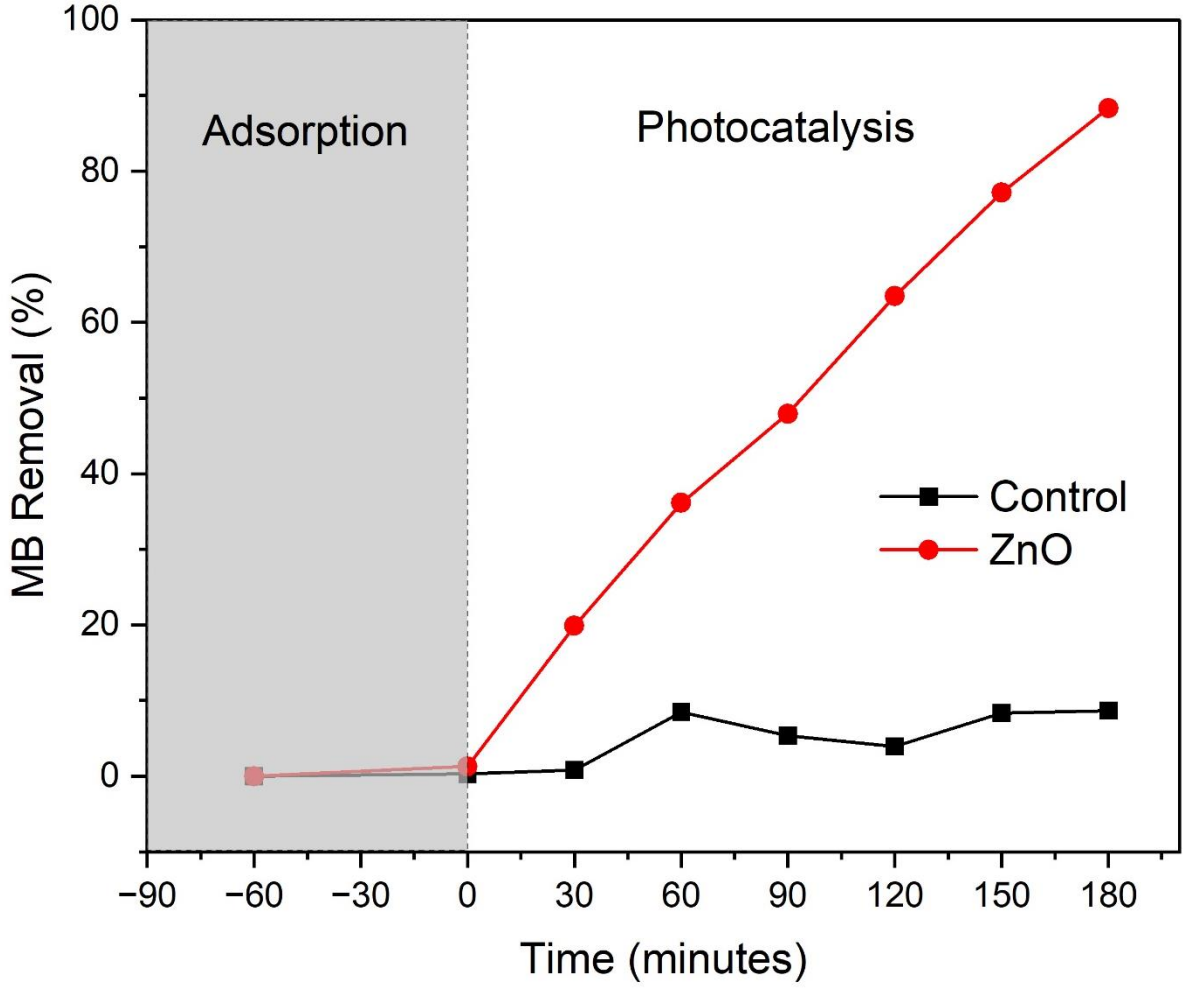


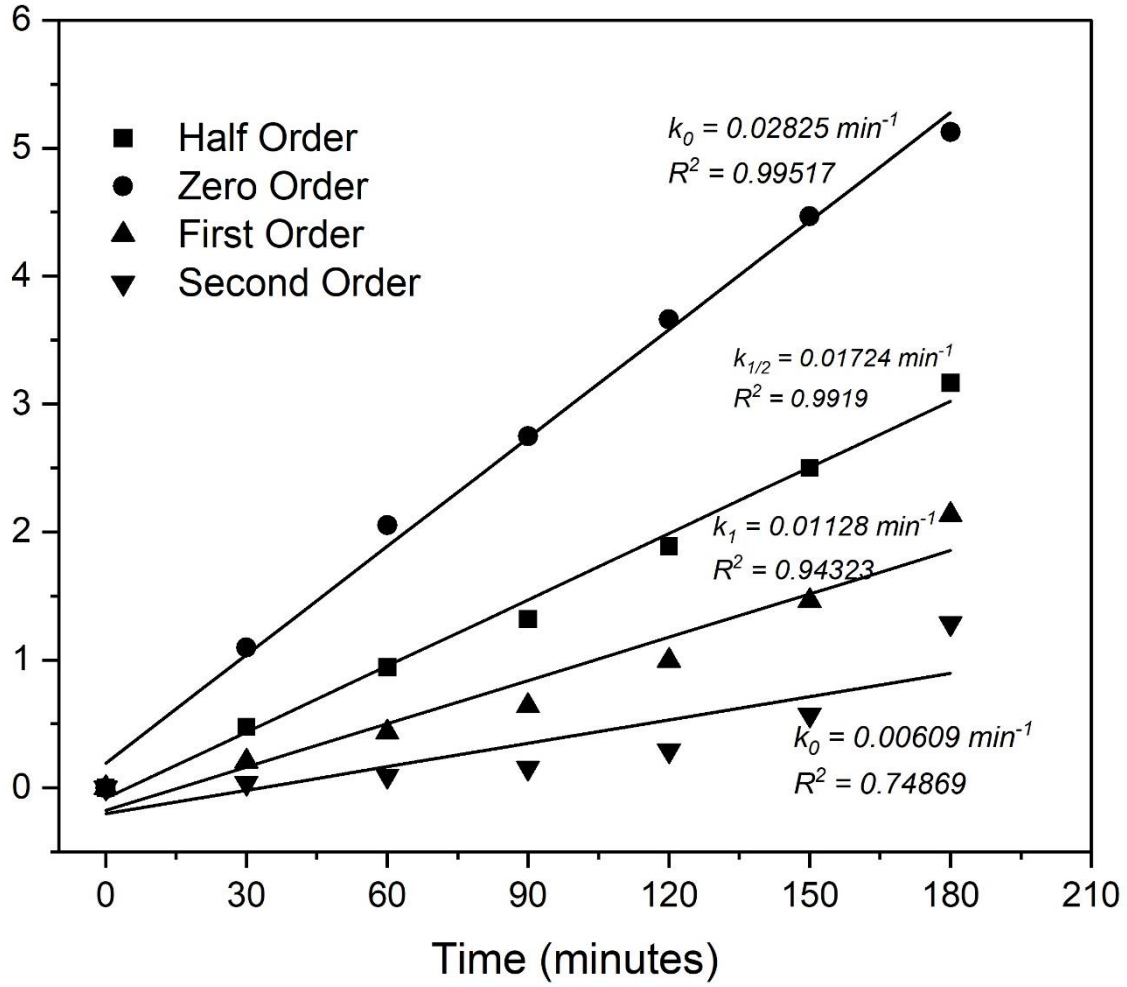




Results and Discussion Cont'd

- Catalyst Testing





SDGs Achievable

- This research addresses issues relating to wastewater disposal into surface water which covers the United Nations (UN) sustainable development goals (SDGs) 3, 6, 12 – 14.
- Wastewater treatment is action towards "promoting health and the well-being of all" (SDG 3). In alignment with target 3.9 of the goal, this research contributes to minimizing the risk of fatalities resulting from the release of hazardous substances and pollution.

SDGs Achievable

- The treatment of dye-laden wastewater also responds to SDG 6 to “ensure availability and sustainable use of water”, with particular attention to reducing pollution and disposal of hazardous chemicals into the marine environment.
- This also propels the use of dyes in the textile industry in a manner that facilitates for sustainable production. This falls in line with SDG 12 as the textile effluents could be efficiently treated and reused in various textile processes.

SDGs Achievable

- It is also crucial that the wastewater is handled carefully to preserve life below water from pollution-poisoning as covered by SDG 14.
- It can also be argued that the treatment of wastewater using photocatalysis is a carbon emission free technique as it is able to utilize solar energy for electron activation, which supports the efforts of SDG 13 to combat climate change through reduction of carbon emitting activities.

Conclusions

- ZnO nanoparticles were successfully synthesized, characterized, and applied for photocatalytic degradation of MB.
- Characterization of the nanoparticles revealed a good material crystallinity index > 60%, which is a good property of photocatalytic materials.
- XRD and FTIR analysis showed peaks that conformed to the properties of ZnO highlighted in other literature.
- The results of the photocatalytic degradation tests showed that the synthesized ZnO was able to achieve an MB removal of 88.35%.
- MB degradation kinetics revealed pseudo zero-order degradation kinetics with a reaction rate of 0.02825 min^{-1}.

Conclusions

- Finally, the study also showed that through the application of photocatalysis for wastewater treatment, UN SDGs 3, 6, 12, 13 and 14 can be addressed.

The End

THANK YOU FOR YOUR ATTENTION.