IOCMS 2026 Conference

The 3rd International Online Conference on Mineral Science

10–12 March 2026 | Online

MDPI

Enhanced Photocatalytic Performance of Geochemically Modified Natural Zeolite via Graphene Oxide/Bismuth Oxide Integration

Christianne Aguilar Calma, Denisse Jonel Pavia, Eduardo Magdaluyo Jr.

Department of Mining, Metallurgical and Materials Engineering, College of Engineering, University of the Philippines Diliman, Quezon City 1101, Philippines

INTRODUCTION & AIM

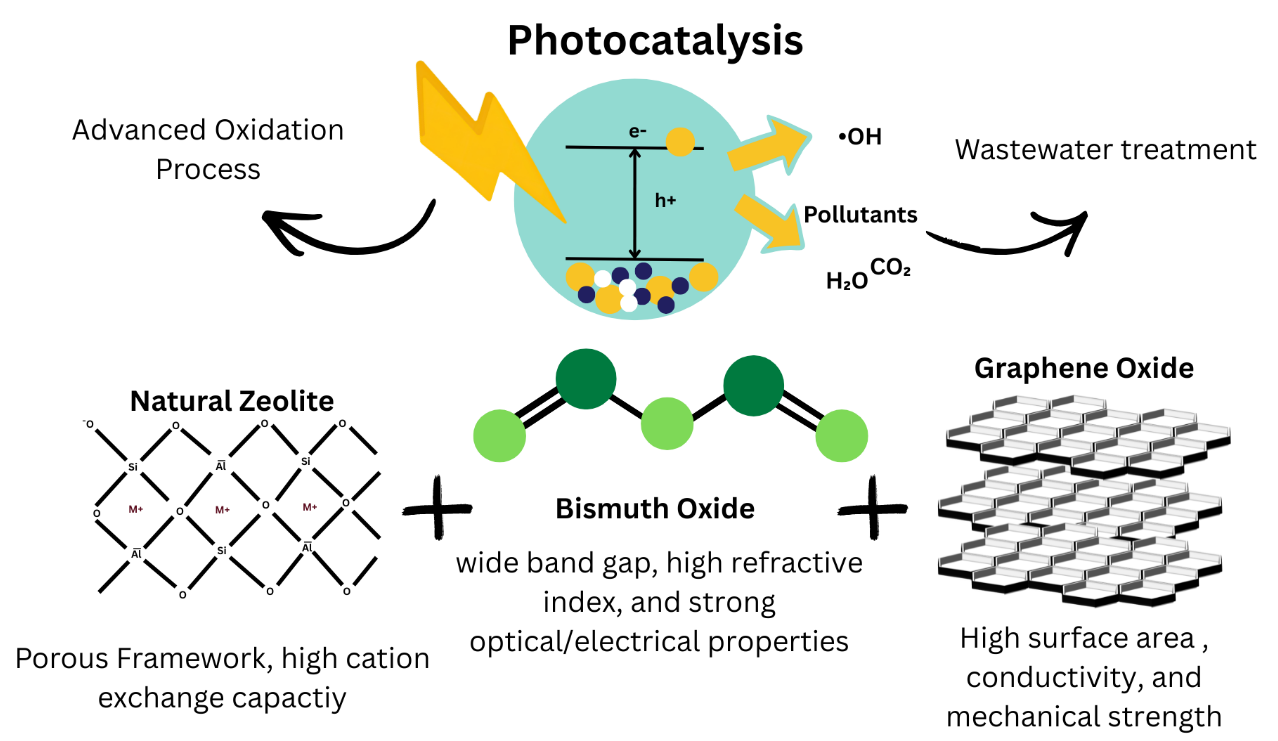


Figure 1. Photocatalysis schematic using NZ, Bi_2O_3, and GO as raw materials.

This study develops a **$GO/NZ/Bi_2O_3$ composite** to enhance photocatalytic degradation efficiency through synergistic phase engineering and surface modification for environmental remediation.

METHOD

SYNTHESIS of NZ/Bi_2O_3 and $GO/NZ/Bi_2O_3$

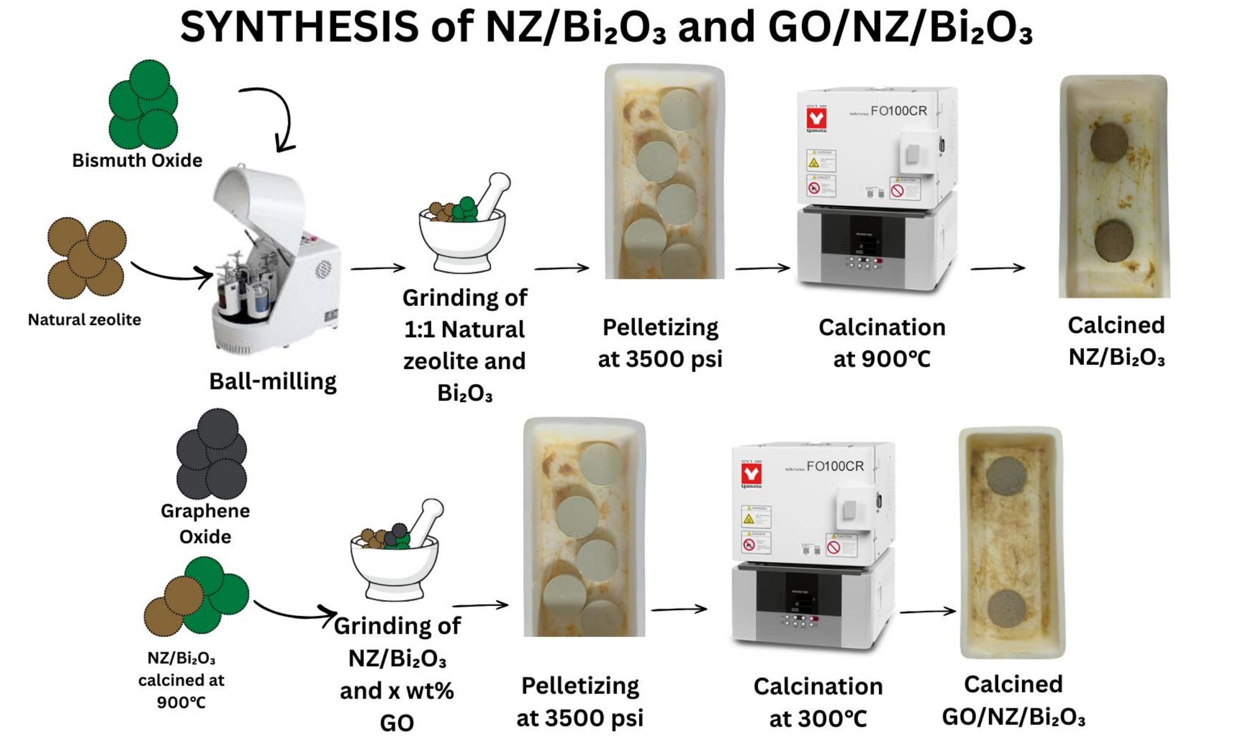


Figure 2. Schematic synthesis routes for NZ/Bi_2O_3 and $GO/NZ/Bi_2O_3$ composites, showing ball-milling, pelletizing, and calcination steps

METHYLENE BLUE DEGRADATION

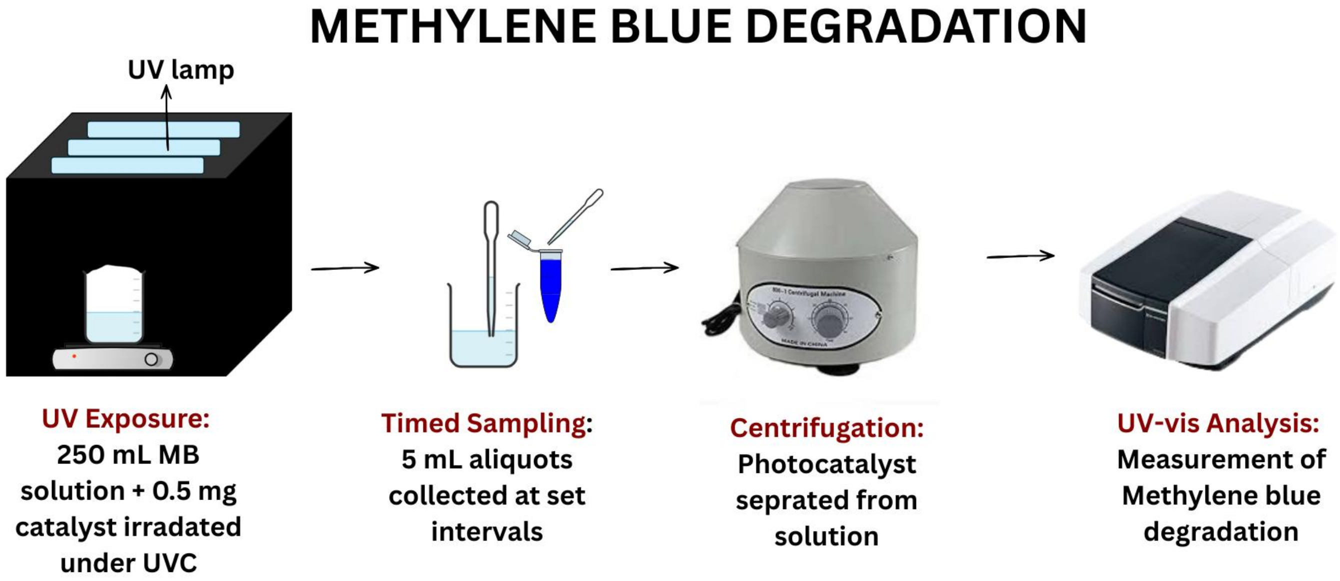


Figure 3. Experimental workflow for photocatalytic methylene blue degradation, including UV exposure, timed sampling, centrifugation, and UV–Vis analysis.

Synthesized NZ/Bi_2O_3 and $GO/NZ/Bi_2O_3$ composites were characterized by **SEM-EDS, FTIR, XRD, BET, Zeta Potential, and TGA.**

RESULTS & DISCUSSION

Morphological Analysis

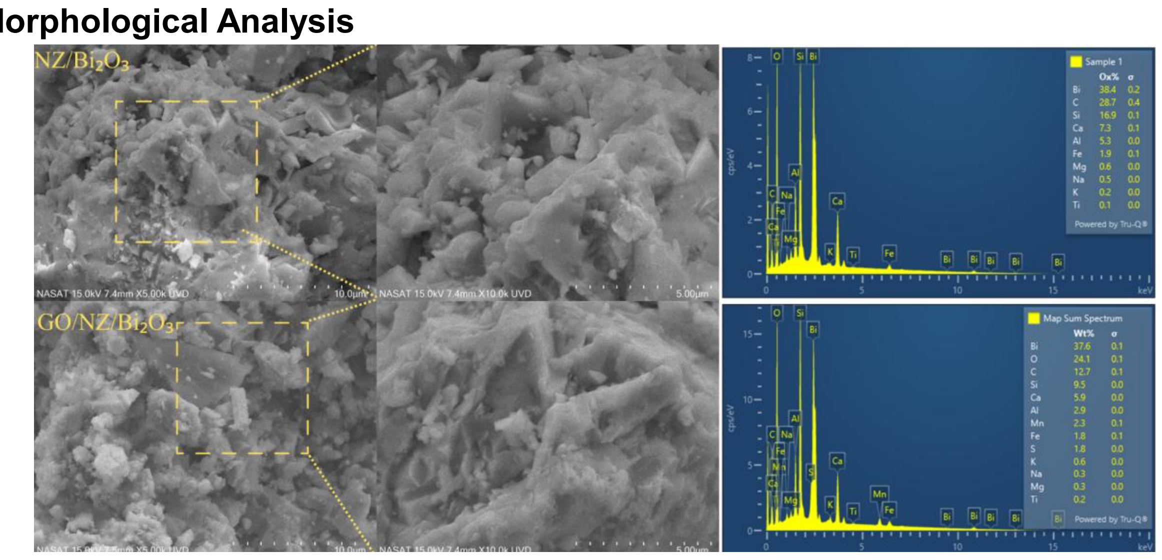


Figure 4. SEM micrographs and EDS elemental mappings of NZ/ Bi_2O_3 and $GO/NZ/Bi_2O_3$

Structural and Chemical Analysis

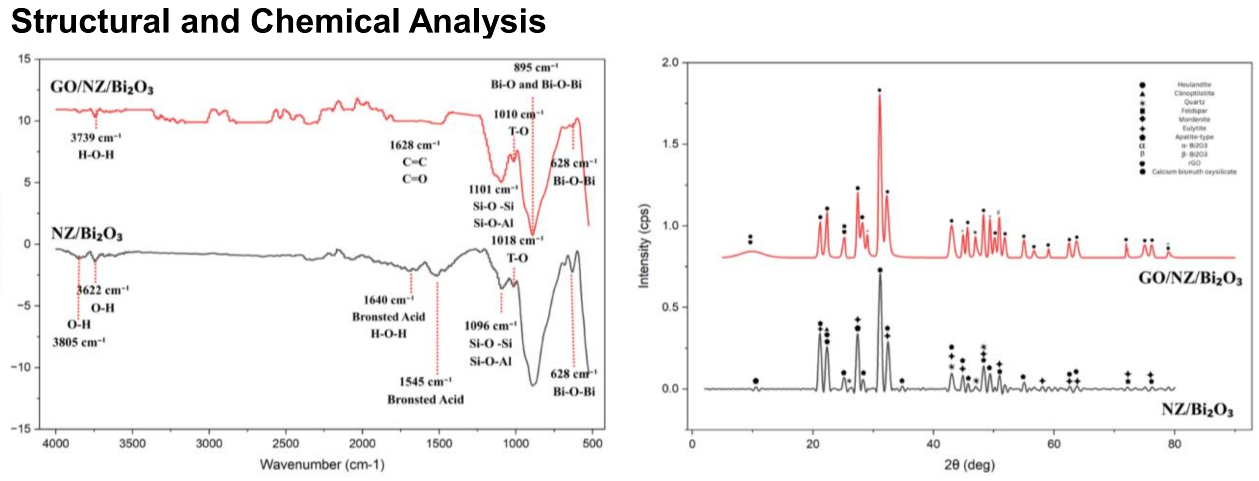


Figure 5. FTIR spectra and XRD patterns of NZ/ Bi_2O_3 and $GO/NZ/Bi_2O_3$

Porosity, Surface Charge, and Thermal Stability Analysis

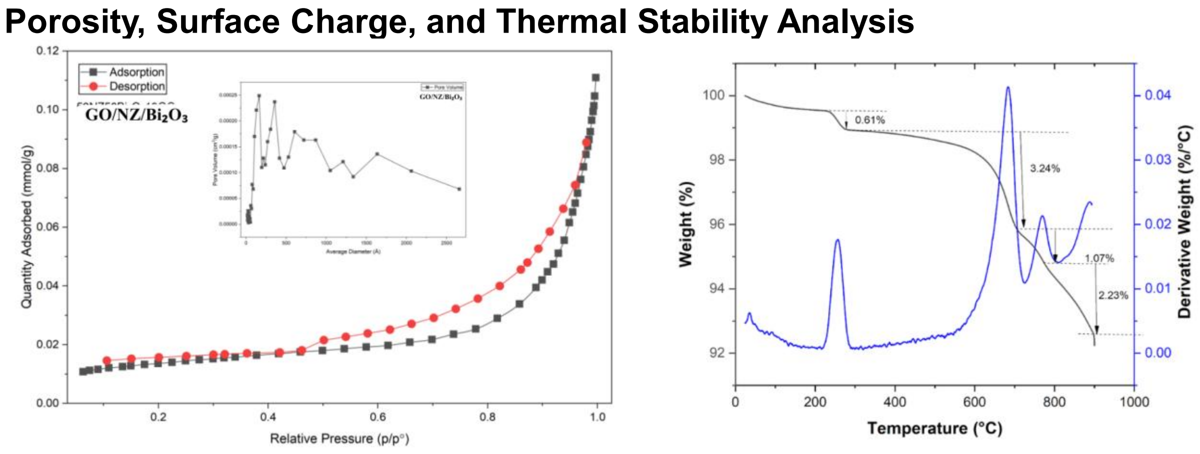
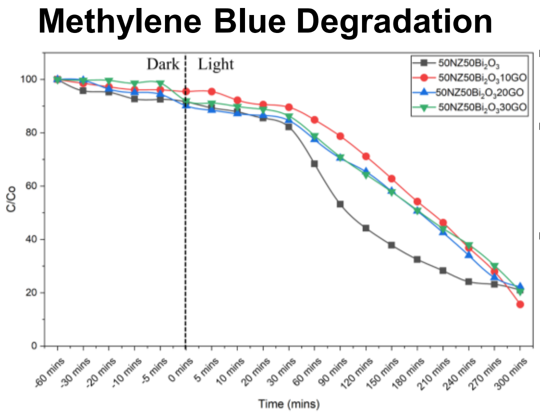


Figure 6. BET/BJH and TGA/DTG plots of NZ/ Bi_2O_3 and $GO/NZ/Bi_2O_3$

Zeta potential analysis showed NZ/Bi_2O_3 was stable **(–33.9 mV)**, while GO addition reduced stability **(–22.5 mV)**, increasing particle aggregation.

Methylene Blue Degradation



- **Dark Phase**: Stable C/Co values confirmed adsorption-desorption equilibrium without UV-driven degradation.
- **Light Phase:** UV exposure triggered photocatalytic activity, with NZ/Bi_2O_3 showing the fastest activity overall.
- **GO Effect:** 10 wt% GO achieved the best balance, enhancing charge transfer without excessive site blocking, while higher GO loadings (20-30 wt%) slowed degradation.

Figure 7. C/Co plot of NZ/ Bi_2O_3 and $GO/NZ/Bi_2O_3$ with varying GO content

CONCLUSION

The integration of Philippine natural zeolite with Bi_2O_3 and graphene oxide produced composites with distinct structural, surface, and thermal properties. Characterization confirmed zeolite framework collapse and Bi–Ca–Si phase formation at high temperature, while GO incorporation introduced rGO features and influenced crystallite size, porosity, and colloidal stability. Despite reduced surface area and stability at higher GO loadings, the composites demonstrated tunable photocatalytic activity, highlighting the importance of optimizing GO content for enhanced performance.

FUTURE WORK / REFERENCES

Gili, M. B., Olegario-Sanchez, L., & Conato, M. (2019). Adsorption uptake of Philippine natural zeolite for Zn2+ ions in aqueous solution. *Journal of Physics: Conference Series*, *1191*, 012042. https://doi.org/10.1088/1742-6596/1191/1/012042

Gili, M. B. Z., Pares, F. A., Nery, A. L. G., Guillermo, N. R. D., Marquez, E. J., & Olegario, E. M. (2020). Changes in the structure, crystallinity, morphology and adsorption property of gamma-irradiated Philippine natural zeolites. *Materials Research Express*, *6*(12), 125552. https://doi.org/10.1088/2053-1591/ab6c8b