ECWS-9 2025 Conference

The 9th International Electronic Conference on Water Sciences

11–14 November 2025 | Online

MDPI

Catalytic performance of carbon nanotubes on glass frits for oxalic acid degradation by ozonation

Marcela P. Spaolonzi, A. Sofia G. G. dos Santos, José R. M. Barbosa, Carla Orge, O. Salomé G. P. Soares, Cátia A. L. Graça*

SRE CM ALiCE

LSRE-LCM – Laboratory of Separation and Reaction Engineering - Laboratory of Catalysis and Materials, Faculty of Engineering, University of Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal

*catiaalgraca@fe.up.pt

U.PORTO FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO

INTRODUCTION

EMERGING CONTAMINANTS

There is a systematic inefficiency in the removal of these pollutants in WWTPs, resulting in a constant cycle of contamination [1].

To solve this problem, advanced oxidation processes have been studied.

IMMOBILIZED CATALYSTS

Growing interest in catalysts supported on inert, macrostructured materials.

Theses systems can obviate post-treatment separation while being appropriate for large-scale implementation.

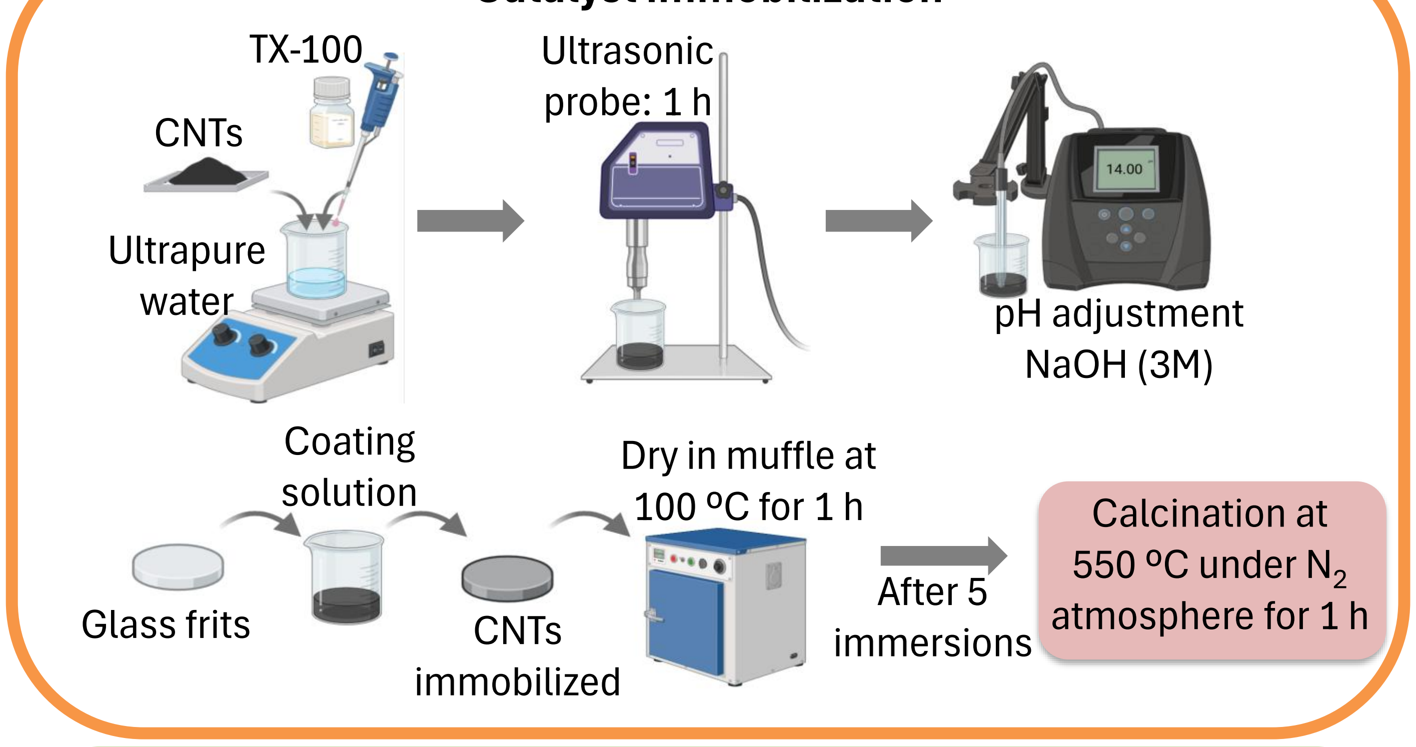
CATALYTIC OZONATION

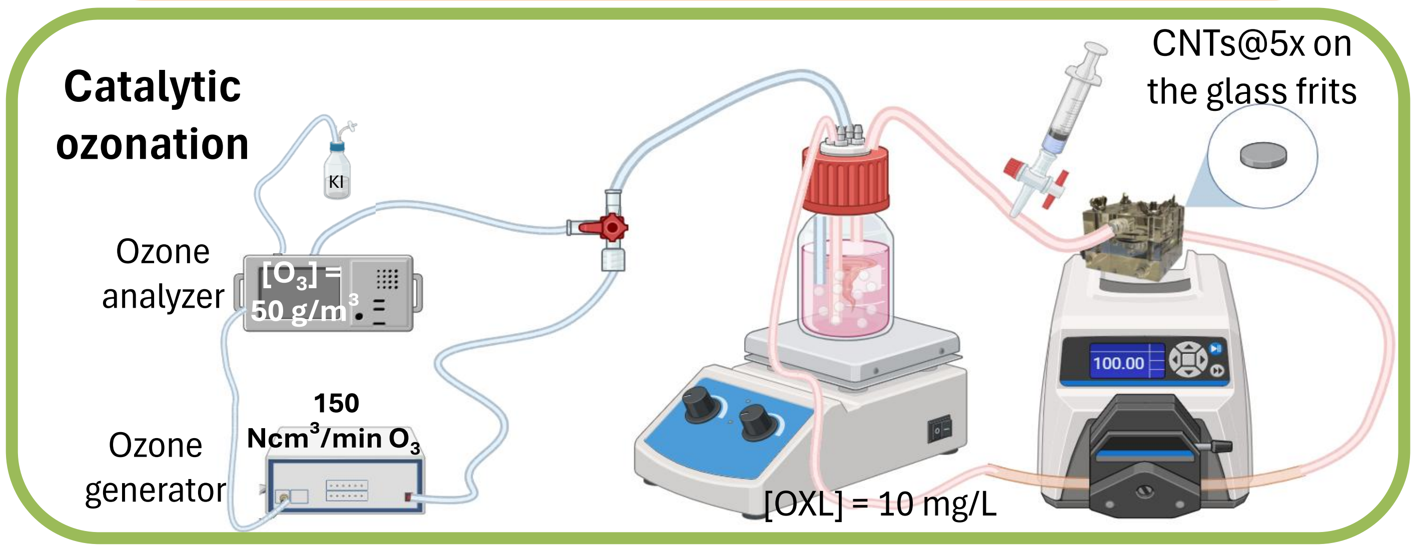
THIS STUDY

❖ The aim of this study was investigated carbon nanotubes (CNTs) supported on glass frits as catalyst on the degradation of oxalic acid (OXL).

- OXL is a typical ozone-resistant byproduct generated during the ozonation of various organic contaminants [2].

METHODOLOGY





RESULTS AND DISCUSSION

- **Immobilization and CNTs@5x efficiency**
  - ✓ 1.9 mg CNTs loading → maximum OXL degradation of 93%
- **Reusability (Fig. 1)**
  - ✓ Up to 5 cycles
  - ✓ Cycles 1 – 3: enhanced efficiency, achieving 93.7% OXL degradation
  - ✓ Cycle 4: sharp decrease (~20% OXL removal)
  - ✓ Cycle 5: recovery in its efficiency (~80% OXL removal)
- **Mass loss (Fig. 2)**
  - ✓ Negligible across cycles, except in the fifth cycle → CNTs@5x lost 21% of its mass

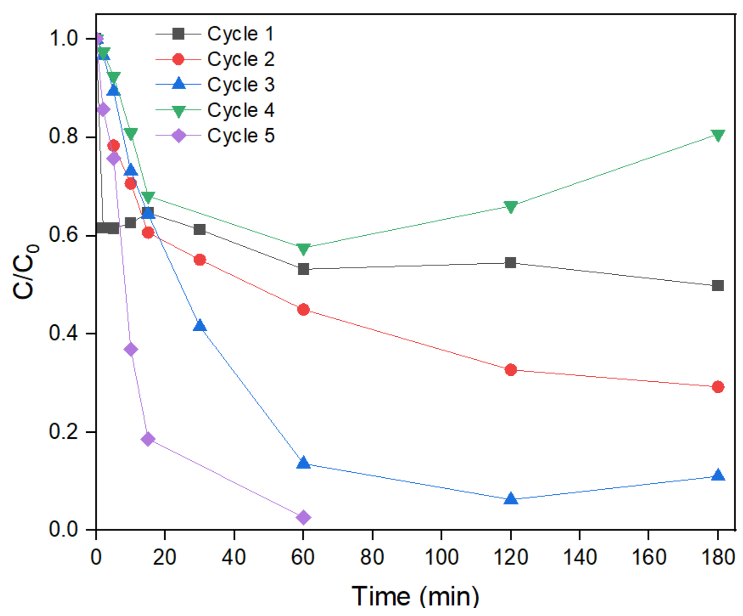


Fig. 1. Oxalic acid degradation with CNTs@5x through the cycles.

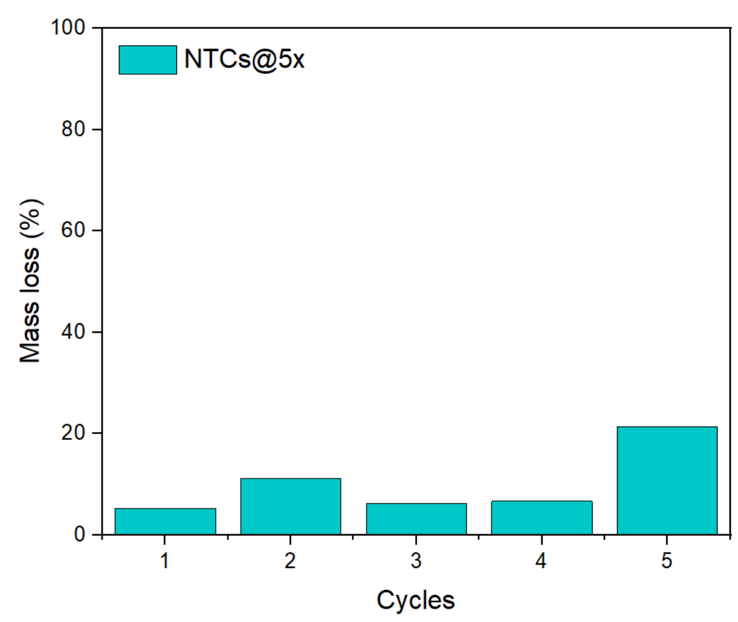


Fig. 2. CNTs@5x mass loss through the cycles.

CONCLUSUIONS

CNTs supported on glass frits demonstrated promising catalytic activity for OXL degradation, combining high efficiency, environmental compatibility, and stable activity over several cycles without the need for any type of reactivation.

ACKNOWLEDGEMENTS

This work was supported by FCT, under Project DIFCATO3, 2023.11502.PEX (DOI: https://doi.org/10.54499/2023.11502.PEX). This research was also financially supported by Fundação para a Ciência e a Tecnologia, I.P. /MCTES through national funds: LSRE-LCM, UID/50020/2025; and ALiCE, LA/P/0045/2020 (DOI: 10.54499/LA/P/0045/2020). C.A.L. Graça thanks FCT funding under the Scientific Employment Stimulus—Individual Call 2022. 08029.CEECIND (DOI: 10.54499/2022.08029.CEECIND/CP1733/CT0010).

fct Fundação para a Ciência e a Tecnologia

REPÚBLICA PORTUGUESA

REFERENCES

[1] M. P. Spaolonzi, E. D. V. Duarte, M. G. Oliveira, H. P. S. Costa, M. C. B. Ribeiro, T. L. Silva, M. G. C. Silva, M. G. A. Vieira, Journal of Cleaner Production, 373 (2022) 133961

[2] C. A. L. Graça, O. S. G. P. Soares, Cleaner Water, 3 (2025) 100069