cbecimat26
26° Congresso Brasileiro de Engenharia e Ciência dos Materiais
November 22–26, 2026
Costão do Santinho
Florianópolis-SC

Development of Iron-Functionalized 3D Carbon Monoliths for the Degradation of Emerging Contaminants via CWPO

Vivian Soares[1]; Marcelo Guerreiro Crizel[1]; Gustavo Lopes Colpani[1]; Rodrigo Brackmann[2]; Márcio Antônio Fiori[2]; Jose Luis Diaz de Tuesta[3]; Liliane Nagi Brambilla[1]; Alexandra Monego Bugiereck[1]; Noelia Corrochano[3]; Josiane Maria Muneron de Mello[1]

1. Unochapecó; 2. Universidade Tecnológica Federal do Paraná – UTFPR/Pato Branco; 3. URJC.

Introduction

Emerging contaminants, such as pharmaceuticals, are persistent and not effectively removed by conventional wastewater treatment processes. Catalytic wet peroxide oxidation (CWPO) is a promising alternative, however, its application requires efficient, stable, and cost-effective catalysts.

The use of 3D-printed carbon monoliths enables the fabrication of porous structures with controlled geometry, enhancing mass transfer and accessibility to catalytic active sites.

Objective

To develop 3D-printed porous carbon monoliths functionalized with iron for application as heterogeneous catalysts in the degradation of emerging contaminants by CWPO.

Methodology

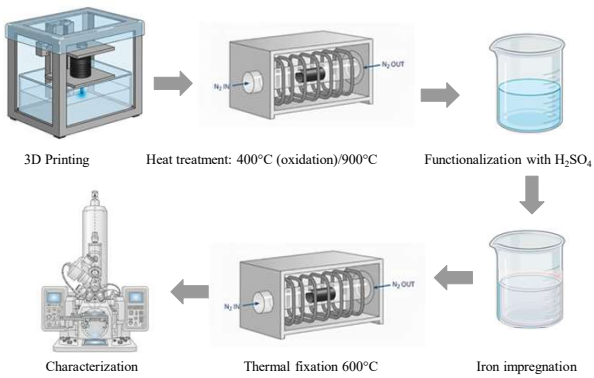


Figure 1. Main steps in the preparation of the iron-functionalized carbon monoliths.

Results and Discussion

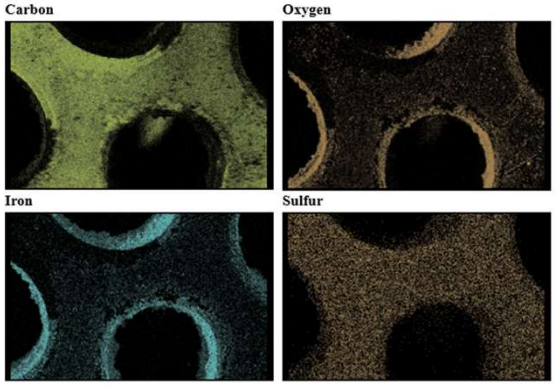


Figure 2. SEM-EDS elemental maps showing the distribution of C, O, Fe, and S in the carbon monolith after iron impregnation and thermal treatment.

EDS analysis revealed an iron content of **14.59 wt% Fe**, while SEM-EDS elemental mapping showing preferential iron accumulation along the pore edges, suggesting improved accessibility to catalytic active sites.

TGA indicated a mass fraction **of 0.33%** which may be associated with iron-containing inorganic species in the carbon monolith.

ICP-MS analysis of the leaching solutions indicated limited iron release, suggesting good retention of the active phase on the carbon support. Preliminary CWPO experiments showed a **degradation efficiency of 20%.**

Conclusions

Iron-functionalized 3D carbon monoliths exhibited successful iron incorporation and a favorable distribution of catalytic sites. The combination of 3D printing and iron functionalization demonstrated potential for developing structured heterogeneous catalysts for emerging contaminant degradation via CWPO.

References and Acknowledgments

CORROCHANO, N. *et al.* From powder to architected monoliths: porous photopolymer-derived carbons for adsorption of nitrophenol isomers in batch and continuous-flow systems. SSRN, 2026

SILVA, A. S. *et al.* 3D printed photopolymer derived carbon catalysts for enhanced wet peroxide oxidation. Chemical Engineering Journal, [s. l.], v. 499, p. 156574, 2024

STELDINGER, H. *et al*. Activated Carbon in the Third Dimension-3D Printing of a Tuned Porous Carbon. Advanced Science, [s. l.], v. 6, n. 19, p. 1901340, 2019.

The authors thank Unochapecó, CeTAE and Universidad Rey Juan Carlos (Spain) for the technical support and infrastructure provided. This work was supported by CAPES (Finance Code 001).