Biodiversity restoration and conservation of inland water ecosystems for environmental and human well-being

BioReset

BiodivRestore-406

2020 - 2021 Joint Call
Joint COFUND Call on "Conservation and restoration of degraded ecosystems and their biodiversity, including a focus on aquatic systems"

Deliverable 2.1.3
Method for Biosorbent Regeneration

Lead Beneficiary	Work package	Delivery month
UVIGO	**2**	**30**

1. Executive Summary

BioReset proposes to advance treatment processes (chemical, physical, biological and their combination) to promote ecosystem recovery and conservation and to develop assessment strategies. Diatoms will be used to model ecosystem conservation and restoration since their communities show high levels of biodiversity. The diatoms will provide an expeditious method to compare different recovery strategies and water treatment processes, allowing to address timescale and key conservation/restoration questions. The full environmental, economic, and social viability of the upgraded and innovative treatment technologies will be assessed. Based on this knowledge, scale-up studies in geographically different sites (Portugal and Spain) will be performed to ascertain the technical and economic feasibility at a larger scale and recommended action guidelines will be issued.
BioReset also envisages the creation of a representative space-time picture of the presence of emerging contaminants in inland waters and its correlation to effects on diatom communities. For this, powerful analytical techniques, such as gas- and liquid chromatography, will be used. Besides these methods, and to obtain real-time information, miniaturized analytical platforms that can perform fast and *on-site* monitoring will also be employed.
Thus, an important point here is the high need for technologies to improve wastewater (WW) treatment, creating the necessary water quality to nurture ecosystem recovery. ***Deliverable 2.1.3*** is intended to provide the details of the work developed for Work Package (WP) 2, within **BioReset**. Additional information regarding communication and academic works within the WP is outlined in this report.

2. Task description

WP2 regards improving the effectiveness and upscaling of WW treatments. Within this, Task 2.1 – "Advanced oxidation processes (AOPs) with simultaneous adsorption" a concentration-degradation-purification strategy was developed by combining adsorption and AOPs in order to achieve the removal of emerging contaminants (EC) and improvement of water quality. Eco-innovative technologies were developed to produce biosorbents with high adsorption capability and selectivity for the target ECs. This was achieved by means of the recovery and use of industrial wastes, turning them into valuable and useful raw materials for the synthesis of biosorbents by thermal and hydrothermal processes. After the concentration of the EC onto the biosorbents optimal AOPs to regenerate and recycle them are being developed. In this process, the sensors developed in Task 1.2 will be used to determine the evolution of EC degradation and the effect of the operational conditions to reduce energy consumption while keeping a high efficiency. ***Deliverable 2.1.3*** is focused on the subtask: **iv)** regeneration of spent adsorbent by desorption, electrodesorption or in situ degradation of EC using AOPs.

3. WP2 team members

The Team members in WP2, task 2.1 are detailed as follows:

Name	Organization	Role
M. Ángeles Sanromán Braga	UVIGO	Task coordinator
Marta Pazos Currás	UVIGO	Researcher
Emilio Rosales Villanueva	UVIGO	Researcher
Elisa González Romero	UVIGO	Researcher
Aida Diez Sarabia	UVIGO	Researcher
Bárbara Lomba Fernández	UVIGO	Researcher
Nuria Bernárdez Rodas	UVIGO	Researcher
Antía Fernández Sanromán	UVIGO	Researcher
Cristina Delerue-Matos	REQUIMTE	Project coordinator
Manuela Correia	REQUIMTE	Researcher
Valentina Domingues	REQUIMTE	Researcher
Virgínia Cruz Fernandes	REQUIMTE	Researcher
Sónia Figueiredo	REQUIMTE	Researcher

Name	Organization	Role
Olga Freitas	REQUIMTE	Researcher
Hendrikus Nouws	REQUIMTE	Researcher
João Pacheco	REQUIMTE	Researcher
Paula Paíga	REQUIMTE	Researcher
Malin Hultberg	SLU	Researcher
Oksana Golovko	SLU	Researcher
Laura Ferrando-Climent	IFE	Researcher
Christian Dye	IFE	Researcher
Carlos Escudero Oñate	IFE	Researcher
Mario Silva	IFE	Researcher
Sandra Jorge	AdCL	Researcher
Rita Ribeiro	AdCL	Researcher
Joana Vieira	AdCL	Researcher

4. Developed activities

WP2 focuses on enhancing the effectiveness and scalability of wastewater treatment technologies. This deliverable presents the regeneration strategies developed under Task 2.1 of the BioReset project, specifically targeting the reuse of biosorbents saturated with ECs. Regeneration is essential to improve the sustainability, efficiency, and economic viability of adsorption-based wastewater treatment processes. Following the synthesis (Deliverable D2.1.1) and adsorption performance testing (Deliverable D2.1.2) of novel biosorbents derived from agro-industrial residues, this report evaluates different regeneration protocols aimed at extending biosorbent lifespan and reducing the need for continuous production. The use of *in-situ* regeneration strategies not only restores adsorption capacity but also facilitates the degradation of retained contaminants, minimizing secondary pollution. Monitoring of the regeneration processes was supported by sensor technologies developed in Task 1.2.

Within the scope of this deliverable, three regeneration methods were systematically implemented and assessed: i) Desorption-based regeneration, where saturated biosorbents were treated with solvents such as methanol or alkaline aqueous solutions. The procedure involved stirring the biosorbents in solvent media, filtering, drying, and testing the reusability over successive cycles; ii) Heterogeneous based-Fenton process using synthesized carbonous materials alone or in combination with metals catalyst. This process facilitated in-situ degradation of adsorbed contaminants, restoring the biosorbent's activity. The catalyst's stability and material integrity were evaluated exhibiting higher durability, and iii) Low-voltage 3D electro-Fenton system, in which the biosorbent material also acted as the third electrode in a packed-bed configuration. This system was tested both in batch and continuous flow modes, including trials with real river water matrices.

The biosorbent materials were previously characterized by their sorptive behavior against a selection of ECs including fluoxetine, sulfamethoxazole, sulfamethizole, antipyrine, and diclofenac. These contaminants were selected based on their frequent occurrence in municipal wastewater and their recalcitrance to conventional biological treatment. As part of the current task, new biosorbents were synthesized through thermal and hydrothermal valorization of agro-industrial residues, as outlined in D2.1.1. During this reporting period, the adsorption and catalytic activity of several adsorbents were tested under controlled conditions to determine their capacity for contaminant uptake and their potential for oxidative degradation. Their effectiveness in restoring adsorptive performance and maintaining structural stability over multiple cycles was assessed. The outcomes of this work directly support the broader objectives of the BioReset project in promoting ecological and cost-effective remediation solutions for the restoration of inland aquatic ecosystems. The task was carried out in the different activities are shown below:

Desorption-based regeneration

In this approach, saturated biosorbents were subjected to a solvent treatment using methanol or alkaline solutions to remove adsorbed ECs. The protocol consisted of mechanically stirring the spent biosorbents in the regeneration medium for 60 minutes, followed by filtration and drying at 60 °C. The regenerated materials were reused in subsequent adsorption cycles to assess capacity retention. High-performance liquid chromatography (HPLC) was used to quantify residual contaminants. Although this approach is cost-effective and simple, a progressive decline in adsorption efficiency was observed due to incomplete desorption and potential fouling. This task was conducted by junior researchers from the University of Vigo during their final-year internships in Industrial Chemical Engineering, and two PhD students (Nuria Bernárdez and Barbara Lomba) whose thesis will be defended next year.

Heterogeneous based-Fenton Regeneration

The heterogeneous Fenton regeneration methodology developed across this time is characterized by an integrated approach combining advanced materials design, catalyst stabilization, and process intensification. A wide range of solid catalysts have been synthesized and applied, including Fe-based metal-organic frameworks (MOFs), $ZnCo_2O_4$ spinels, ZnO/g-C_3N_4 composites, MnCuFe-layered double hydroxides (LDHs), and Fe-Ti nanoparticles obtained using deep eutectic solvents. These heterogeneous materials allow for the localized and reusable generation of hydroxyl radicals, minimizing the need for dissolved iron. Special attention has been given to the immobilization and stabilization of catalysts like graphitic carbon nitride (g-C_3N_4), employing strategies such as electrospinning to fabricate nanofiber membranes, which serve as durable catalytic platforms. Integration with electrochemical and photocatalytic systems has played a crucial role in enhancing regeneration. Similarly, photo-Fenton systems under visible light have been explored using catalysts like MnCuFe-LDHs to drive reactions under milder conditions. These methodologies have been successfully tested in complex real wastewater matrices, including pharmaceutical effluents, high-organic-load streams, and dye-contaminated water, demonstrating both efficiency and operational robustness. In all cases, the reaction conditions were optimized and the degradation of ECs was monitored through chromatographic analysis, and the material integrity was evaluated through repeated regeneration cycles (up to 5). All materials exhibited good catalytic activity and excellent structural stability, confirming its suitability for multiple regeneration cycles without significant performance loss. This approach also minimized secondary waste generation. Overall, the methodological framework relies on the synergy between advanced oxidation processes and adsorption, with a strong focus on catalyst recyclability, energy efficiency, and environmental sustainability. This coherent approach underlines the significant progress made in the design of regenerable, heterogeneous Fenton systems for wastewater treatment. The work was

performed by several PhD students of different international universities in their stages in our lab. It is important to highlight the collaboration of several students of Chemical Engineering of the University of Vigo and the experiments carried out by the PhD student contracted with funding from the BioRest project, Barbara Lomba.

3D Electro-Fenton Regeneration System

The third approach employed a low-voltage 3D electro-Fenton system, where biosorbents acted as the third electrode in a packed-bed configuration between graphite anode and cathode plates. Application of a 1.2 V potential generated hydrogen peroxide electrochemically, enabling simultaneous electrosorption and oxidative regeneration. Both batch and continuous flow configurations were tested, including trials using real river water. Additional regeneration trials using NaOH-activated peroxymonosulfate and low-voltage cycles were conducted on natural adsorbents such as Tunisian clay and forest-derived biochar. These experiments were developed in cooperation with teams from the University of Vigo, REQUIMTE, and the University Rey Juan Carlos (Spain). The work was led by BioReset-funded PhD student Nuria Bernárdez-Rodas.

All regeneration methods were comprehensively assessed based on EC removal efficiency, biosorbent structural preservation, and operational feasibility. Characterization of the biosorbents included BET surface area analysis, FTIR spectroscopy, scanning electron microscopy (SEM), and electrochemical impedance spectroscopy (EIS). The results confirm that these regeneration strategies are effective, scalable, and aligned with the circular economy principles, making a valuable contribution to the BioReset project's objectives for sustainable restoration of inland aquatic ecosystems.

5. Results

Initially, various solvents were screened for their desorption efficiency, with methanol emerging as the most effective across the range of tested ECs and biosorbents. Methanol-based desorption achieved up to 75% pollutant removal in the first regeneration cycle. However, a notable decline in sorption capacity was observed after three cycles, indicating limited suitability for long-term reuse. This method, while simple and low-cost, demonstrated suboptimal performance in terms of durability and regeneration potential.

In contrast, the heterogeneous Fenton regeneration process, utilizing different synthesized materials as both adsorbent and catalyst, yielded higher degradation efficiencies, ranging from 72% to 97% depending on the ECs. The structural stability of the adsorbents was maintained throughout all cycles, as confirmed by BET surface area measurements, FTIR spectroscopy, and SEM imaging.

The 3D electro-Fenton system exhibited the highest regeneration performance among the evaluated methods. It consistently achieved over 90% contaminant removal, and in some instances, enhanced adsorption capacity after the first regeneration cycle, likely due to improved pore accessibility following electrochemical treatment. This system also showed excellent performance under continuous-flow conditions, combined with low energy requirements and stable efficiency across five regeneration cycles.

Based on the experimental outcomes, it can be concluded that regeneration through AOPs, particularly via heterogeneous photo-Fenton and 3D electro-Fenton systems, offers a significantly more effective and sustainable alternative to conventional desorption methods. These AOP-based strategies allow for simultaneous degradation of adsorbed ECs and functional recovery of biosorbents, eliminating the need for additional post-treatment. Biosorbents regenerated using these methods preserved both structural integrity and adsorption capacity across multiple cycles, confirming their potential for integration into real-world wastewater treatment systems. Among the tested protocols, the 3D electro-Fenton approach stands out due to its operational flexibility, scalability potential, and low energy footprint, making it a promising candidate for advanced water treatment applications.

More detail in the results obtained are disclosed in the different communications in conferences and also in several journal articles (see section 6 associated indicators).

6. Associated indicators

The associated indicators included also studies related to the wastewater treatment and the synthesis and characterization of new materials.

Publications

1. Mkaddem, H., Fdez-Sanromán, A., Rosales, E., Pazos, M., Benamor, H., Sanromán, M.A. (2025). Efficient degradation of organic pollutants using MnCuFe-LDH as a photo-fenton catalyst. Chemical Engineering Science, 311, 121611. DOI: 10.1016/j.ces.2025.121611.
2. Bernárdez-Rodas, N., Rosales, E., Pazos, M., Sanromán, M.Á. (2025). Innovative low-voltage 3D electrode system using pine cone biochar for efficient removal of multicomponent pollutants from wastewater. Journal of Water Process Engineering, 74, 107744. DOI: 10.1016/j.jwpe.2025.107744.
3. Zouggari, H., Mahir, F.-Z., Diez, A.M., Djellabi, R., Sanromán, M.Á., Pazos, M., Laabd, M., Bazzi, L., Albourine, A. (2025). Novel polypyrrole-coated ZnCo2O4 spinel nanostructures for prompt and efficient adsorption of Cr(VI) from wastewater. Applied Surface Science, 688, 162407. DOI: 10.1016/j.apsusc.2025.162407.
4. Bernárdez-Rodas, N., Rosales, E., Pazos, M., González-Prieto, Á., Torres, L.O., Sanromán, Á. (2025). Three-Dimensional Electrosorption for Pharmaceutical Wastewater Management and Sustainable Biochar Regeneration. Molecules, 30(7), 1435. DOI: 10.3390/molecules30071435.
5. Lomba-Fernández, B., Pazos, M., Rosales, E., Sanromán, M.Á. (2025). Synthesis of ZnO/g-C3N4 Composites Obtained by Pyrolysis of a Ternary Deep Eutectic Solvent and Their Application as Catalysts in Different AOPs. Applied Sciences, 15(5), 2475. DOI: 10.3390/app15052475.
6. Atawa, O., Escudero-Curiel, S., Amor, H.B., Ouakouak, A., Hamdi, N., Pazos, M., Sanromán, Á. (2025). Efficient fluoxetine removal from water using Tunisian clay as adsorbent and its regeneration through NaOH-activated peroxymonosulfate. Chemical Engineering Science, 304, 120998. DOI: 10.1016/j.ces.2024.120998.
7. Fdez-Sanromán, A., Díez, A.M., Sanromán, M.A., Rosales, E., Pazos, M. (2025). Enhancing sulfamethizole adsorption on graphitic carbon nitride via coffee hydrochar incorporation and electric field application in different water matrices. Journal of Cleaner Production, 486, 144456. DOI: 10.1016/j.jclepro.2024.144456.
8. Tesnim, D., Díez, A.M., Ben Amor, H., Angeles Sanromán, M., Pazos, M. (2024). Synthesis and characterization of eco-friendly cathodic electrodes incorporating nano Zero-Valent iron (NZVI) for the electro-fenton treatment of pharmaceutical wastewater. Chemical Engineering Journal, 502, 158099. DOI: 10.1016/j.cej.2024.158099.
9. Lomba-Fernández, B., Fdez-Sanromán, A., Pazos, M., Sanromán, M.A., Rosales, E. (2024). Iron metal-organic framework nanofiber membrane for the integration of electro-Fenton and effective continuous treatment of pharmaceuticals in water. Chemosphere, 366, 143447.DOI: 10.1016/j.chemosphere.2024.143447.
10. Caruncho-Pérez, S., Díez, A.M., Prado-Comesaña, A., Pazos, M., Sanromán, M.Á., González-Romero, E. (2024). Decorated Electrode Surfaces with Nanostructures and Metal-Organic Frameworks as Transducers for Sensing. Sensors, 24(20), 6745. DOI: 10.3390/s24206745.
11. Bouzayani, B., Lomba-Fernández, B., Fdez-Sanromán, A., Elaoud, S.C., Sanromán, M.Á. (2024). Advancements in Copper-Based Catalysts for Efficient Generation of Reactive Oxygen Species from Peroxymonosulfate. Applied Sciences, 14(17), 8075. DOI: 10.3390/app14178075
12. Cruz del Álamo, A., Puga, A., Dias Soares, C.M., Pariente, M.I., Pazos, M., Molina, R., Sanromán, M.A., Martínez, F., Delerue-Matos, C. (2024). Novel 3D electro-Fenton reactor based on a catalytic packed bed reactor of perovskite/carbon microelectrodes for the removal of carbamazepine in wastewater. Journal of Environmental Chemical Engineering, 12(4), 113154. DOI: 10.1016/j.jece.2024.113154
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18. Puga, A., Moreira, M.M., Sanromán, M.A., Pazos, M.M., Delerue-Matos, C. (2024). Antidepressants and COVID-19: Increased use, occurrence in water and effects and consequences on aquatic environment. A review. Science of the Total Environment, 953, 175993. DOI: 10.1016/j.scitotenv.2024.175993

Communications

1. S. Fernández-Davila, M. Rúa-Pereira, M. A. Sanromán, E. Rosales. Conversion of agroindustrial wastes into low-cost adsorbents for efficient organic pollutant removal by hydrothermal carbonization. XXVII Encontro Galego-Portugués de Química. 22-24 November 2023, Porto, Portugal, Poster presentation.
2. V. Poza-Nogueiras, A.M. Díez, M. Pazos, M.A. Sanromán. Synthesis of eco-friendly biosorbents to be applied for the removal of pharmaceuticals. XXVII Encontro Galego-Portugués de Química. 22-24 November 2023, Porto, Portugal, Oral presentation.
3. V. Poza-Nogueiras, A. Casanova, M. Pazos, C.O. Ania, M.A. Sanromán. Exploring the use of carbon gels in the treatment of polluted water. XXVII Encontro Galego-Portugués de Química. 22-24 November 2023, Porto, Portugal, Poster presentation.
4. M. Pazos, A Díez, S Escudero, A Fdez-Sanromán, D Terrón, E Rosales, M A Sanromán. Advances in the eco-design and synthesis of materials for the aquatic environment restoration. 5th International Symposium on Materials, Electrochemistry and Environment, CIMEE 23, 21-23 September 2023, Trípoli, Lebanon, Keynote lecture.
5. V. Poza-Nogueiras, M. Pazos, M.A. Sanromán. Advanced oxidation processes for the treatment of pharmaceuticals in aqueous matrices. BioReset Conference. 18-19 April 2024, Porto, Portugal, Oral presentation.
6. M Pazos, S Escudero-Curiel, D Terrón, A Fdez-Sanromán, A M Díez, E Rosales, M A Sanromán. Progress in eco-friendly material design and synthesis for environmental purposes. BioReset Conference. 18-19 April 2024, Porto, Portugal, Oral presentation.
7. V. Poza-Nogueiras, A. Giráldez, A.M. Díez, M. Pazos, M.A. Sanromán. Eliminación de fármacos presentes en aguas utilizando piel de plátano. Mesa Española de Tratamiento de Aguas (META). XV Congreso Español de Tratamiento de Aguas. 19-21 June 2024, A Coruña, Spain, Poster presentation.
8. N. Bernárdez, M. Pazos, E. Rosales, M.A. Sanromán. Valorización de residuos forestales y su aplicación en la eliminación de contaminantes recalcitrantes. Mesa Española de Tratamiento de Aguas (META). XV Congreso español de tratamiento de aguas. 19-21 June 2024, A Coruña, Spain, Oral presentation.
9. N. Bernárdez, M. Pazos, E. Rosales y M.A. Sanromán. Aplicación y escalado de Procesos de Oxidación Avanzada combinados con técnicas de adsorción. Mesa Española de Tratamiento de Aguas (META). XV Congreso español de tratamiento de aguas. 19-21 June 2024, A Coruña, Spain, Poster presentation.
10. B. Lomba-Fernández, A. Fdez-Santomán, E. Rosales, M. Pazos, M.A. Sanromán. Síntesis de nanofibras mediante electrospinning y su aplicación en el tratamiento de aguas contaminadas con fármacos. Mesa Española de Tratamiento de Aguas (META). XV Congreso español de tratamiento de aguas. 19-21 June 2024, A Coruña, Spain, Poster presentation.
11. A. Fdez-Sanromán, B. Lomba-Fernández, M.A. Sanromán, M. Pazos, E. Rosales. Optimización de Fotocatalizadores de Nitruro de Carbono Grafítico para la Eliminación de Contaminantes Coloreados en Agua. Mesa Española de Tratamiento de Aguas (META). XV Congreso Español de Tratamiento de Aguas. 19-21 June 2024, A Coruña, Spain, Poster presentation.
12. M. Díez, Clara Gómez-González, M. Pazos, M. A. Sanromán. Integración de adsorción y degradación mediante Procesos de Oxidación Avanzada: un nuevo enfoque para futuras aplicaciones. Mesa Española de Tratamiento de Aguas (META). XV Congreso español de tratamiento de aguas. 19-21 June 2024, A Coruña, Spain, Oral presentation.
13. M. Díez, N. Iberache, M. Pazos, M. A. Sanromán. Optimizando el proceso Foto-Fenton: funcionalización de g-C3N4 con partículas nano cero valentes de MnFe. Mesa Española de Tratamiento de Aguas (META). XV Congreso español de tratamiento de aguas. 19-21 June 2024, A Coruña, Spain, Poster presentation.
14. A. Fdez-Sanroman, D. Terron, B. Lomba-Fernández, E. Rosales, M.A. Sanromán, M. Pazos. Bimetallic Metal-Organic Frameworks: Efficient Catalysts for Water Disinfection via Advanced Oxidation Processes. XII International Symposium on Environmental Engineering SIDISA2024. 1-4 October 2024, Palermo, Italy, Poster presentation.
15. A. Fdez-Sanroman, N. Bermudez, B. Lomba-Fernández, A. Díez, E. Rosales, M.A. Sanromán, M. Pazos. Enhancing pollutant adsorption and adsorbent regeneration via Electro- or Photochemical integration. XII International Symposium on Environmental Engineering SIDISA 2024. 1-4 October 2024, Palermo, Italy, Poster presentation.
16. A.M Díez, M. Pazos, M. A. Sanromán. Adsorption coupled to AOPs to have a quick and definitive elimination treatment of pharmaceuticals from real wastewaters. CIPOA – VI Iberoamerican Conference on Advanced Oxidation Technologies. 7-11 October 2024, Santa Catarina, Brazil, Poster presentation.
17. A. Fdez-Sanromán, B. Lomba-Fernández, M. Pazos, E. Rosales,y M. A. Sanromán. Modificaciones y optimización del nitruro de carbono grafítico y sus técnicas de inmovilización para la eliminación de contaminantes coloreados en agua. XXVIII Encontro Galego Portugués de Química. 13-15 November 2024, Vigo, Spain, Oral presentation.
18. A. Fdez-Sanromán, M. Pazos, M. A. Sanromán, E. Rosales. Versatilidad del Fe-MOF en diversos procesos de oxidación avanzada para la descontaminación y desinfección de aguas. XXVIII Encontro Galego-Portugués de Química. 13-15 November 2024, Vigo, Spain, Poster presentation.
19. N. Bernárdez, E. Rosales, M. Pazos, M.A. Sanromán. Evaluation and optimization of a multielectrode system for the treatment of effluents with high organic matter content. XXVIII Encontro Galego-Portugués de Química. 13-15 November 2024, Vigo, Spain, Poster presentation.

20. B. Lomba-Fernández, A. Fdez-Sanromán, E. Rosales, M. Pazos, M.A. Sanromán. Electrospun Fe-MOF nanofiber membranes: Synthesis and catalytic application in the Electro-Fenton process. XXVIII Encontro Galego-Portugués de Química. 13-15 November 2024, Vigo, Spain, Oral presentation.
21. B. Lomba-Fernández, E. Rosales, M. Pazos, M.A. Sanromán. Synthesis of Zn and Fe nanocomposites obtained by pyrolysis of ternary deep eutectic solvents for catalytic water treatment applications. XXVIII Encontro Galego-Portugués de Química. 13-15 November 2024, Vigo, Spain, Poster presentation.
22. A. Fdez-Sanromán, A.R. Ozdemir, E. Rosales, A. Sanromán, Y. Budama-Kilinc, M. Pazos. Oxidant Encapsulation: Release and Enhancement of Treatment for Dye-Contaminated Water. Winter School on Contaminants of Emerging Concern (CECs) and Disinfection By-Products (DBPs): Occurrence, Impact and Elimination. 25-26 November 2024, Vila Nova de Gaia, Portugal, Poster presentation.
23. N. Bernárdez, M. Pazos, E. Rosales, M.A. Sanromán. Implementing and Scaling Electrochemical Techniques Integrated with Adsorption Processes for Water Decontamination. Winter School On Contaminants of Emerging Concern (CECs) and Disinfection By-Products (DBPs): Occurrence, Impact and Elimination. 25-26 November 2024, Vila Nova de Gaia, Portugal, Poster presentation.
24. B. Lomba-Fernández, E. Rosales, M. Pazos, M.A. Sanromán. Synthesis of g-C3N4/Zn nanocomposites obtained by pyrolysis of deep eutectic solvents and their application as a photocatalyst in the treatment of contaminated water. Winter School on CECs and DBPs: Ocurrence, Impact and Elimination. 25-26 November 25-26 November 2024, Vila Nova de Gaia, Portugal, Poster presentation.
25. B. Lomba-Fernández, M. Pazos, E. Rosales, M. A. Sanromán. ZnO/g-C3N4 Composites Prepared Via Deep Eutectic Solvents: A Green Strategy for Dye-Contaminated Water Treatment. 6th Doctoral Congress in Engineering 2025 (DCE25). 30 June-1 July 2025 Porto, Portugal, Poster presentation.
26. N. Bernárdez, E. Rosales, M. Pazos, M.A. Sanromán. Three-dimensional electrosorption of a pharmaceutical mixture via pine cone-derived biochar: batch and continuous mode. 6th Doctoral Congress in Engineering 2025 (DCE25). 30 June-1 July 2025 Porto, Portugal, Oral presentation.
27. N. Bernárdez, E. Rosales, M. Pazos, M.A. Sanromán. Enhanced pharmaceutical pollutants removal by electro-assisted adsorption and biosorbent regeneration. 6th Doctoral Congress in Engineering 2025 (DCE25). 30 June-1 July 2025 Porto, Portugal, Poster presentation.
28. B. Lomba-Fernández, E. Rosales, M. Pazos, M. A. Sanromán. Synthesis of metal nanocomposites obtained by pyrolysis of ternary deep eutectic solvents for catalytic water treatment applications. 7th International Conference on Environmental Applications of Advanced Oxidation Processes (EAAOP-7). 10-13 June 2025 Paestum, Salerno, Italy, Poster presentation.
29. N. Bernárdez, E. Rosales, M. Pazos, M.A. Sanromán. Harnessing biochar from forest residues: Advanced adsorption and electrosorption techniques for efficient pollutant removal in water. 7th International Conference on Environmental Applications of Advanced Oxidation Processes (EAAOP-7). 10-13 June 2025 Paestum, Salerno, Italy, Poster presentation.

Graduation reports

1. Claudia Fernández Pérez. Síntesis de catalizadores verdes y su aplicación en técnicas de oxidación avanzada para el tratamiento eficiente de aguas residuales coloreadas. Degree in Industrial Technologies Engineering, University of Vigo (2024).
2. Felipe Fernández Matías. Integración de hidrochar en estructuras de resina generadas por impresión 3D para su uso como adsorbente en el tratamiento eficiente de aguas. Degree in Industrial Technologies Engineering, University of Vigo (2024).
3. Iris Roel García. Eliminación de fármacos en agua mediante procesos electroquímicos y adsorción. Degree in Industrial Technologies Engineering, University of Vigo (2024).
4. David Otero Romero. Diseño, fabricación y validación de un reactor para el tratamiento de aguas mediante procesos fotocatalíticos heterogéneos. Degree in Industrial Technologies Engineering, University of Vigo (2024).
5. Mencía Marcote Eiranova. Desarrollo de un reactor fotocatalítico operando en UV-A y visible para la eliminación de efluentes coloreados. Degree in Industrial Technologies Engineering, University of Vigo (2024).

Master dissertations

1. Xan Barreiro Xardón. Nuevos catalizadores heterogéneos para el tratamiento de contaminantes emergentes mediante procesos de oxidación avanzada: Nitruros de carbono grafíticos y compuestos derivados. Master's Degree in Chemical Science and Technology UNED (2024).

PhD Thesis defended

1. Antía Fernández Sanromán. Reduction of the environmental and health impact of hospital effluents through advanced oxidation processes. University of Vigo (defense date: December 2024).

PhD Theses in progress

1. Nuria Bernárdez Rodas. Electrochemical techniques integrated with adsorption processes applied in water reuse and conservation strategies. University of Vigo (expected defense date: November 2026).
2. Bárbara Lomba Fernández. Advanced treatment strategies for conservation of water ecosystems. University of Vigo (expected defense date: November 2026).