SusWater BOOKLET 2023

SusWater

Communication and dissemination Activities April 2021- March 2023

The aim of this booklet is to collect all the communication and dissemination activities carried out during the last two years of SusWater action by consortium members. In particular, the present release of the Booklet covers the period from April 2021 to March 2023.

The SusWater Consortium

Contents

ACTIVITIES FOR PUBLIC AT LARGE

SusWater consortium considers very important the bi-directional process involving the public in interaction and listening, with the goal to achieve a mutual benefit. For these reasons, the participants of the project attended/organized events to involve students and the public at large to share the aim and the results of SusWater.

The public engagement activities performed in these two years are reported below:

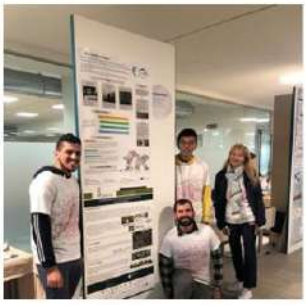
1. Participation to the European Researchers' Night

- **European Researchers' Night 2021, in Turin, Italy (September 24th, 2021)**.

Our researchers showed their experiments and explained their projects to young and old people jointly with the H2020-ITN project AQUAlity, gaining the interest and approval of hundreds of people.
Participants: Paola Calza, Debora Fabbri, Mery Malandrino, Giovanna Cristina Varese, Federica Spina, Elisa Gaggero, Monica Rigoletto.

- **European Researchers' Night 2022 (30th September 2022)**, Turin, Italy; a joint activity was performed together with three H2020 Doctorate Networks (AQUAlity, PARACAT and CHASS).
  Participants: Paola Calza, Debora Fabbri, Aleandro Diana, Luca Bertinetti



2. Events

GREENGAME DAY, Next level, non giochiamo con l'ambiente, Conference dedicated to the ecological transition Torino, 24th September 2022 (targeted to students but opened to adults) (https://www.greengame.day/) Marco Sangermano, lesson on ***I materiali polimerici: dal petrolio alle fonti rinnovabili***.

3. Articles in non-scientific magazines

Publication in Platinum Magazine – Research & Innovation pressed and diffused with IlSole24ore. It will be released on March 2023 in Italian and English (Open Access, www.platinum-online.com). Readership: 815.000 readers

Funded by the Horizon 2020 Framework Programme of the European Union
H2020-MSCA-RISE-2020
N° 101007578

Integrated water treatment processes to remove pollutants

Exploitation of sustainable methodologies combining chemical, physical and biological approaches

The SusWater project staff

DeDeveloping new, sustainable and low-cost water treatment processes by integrating biological, chemical and physical approaches is the goal of the "SusWater" European project. Coordinated by the Department of Chemistry of the University of Turin and launched about two years ago, this project faces the challenge of developing new materials starting from waste substances (e.g. soya peels) that exploit sunlight, by taking advantage of the interdisciplinary experience and skills of nine European and non-European partners. It will involve dozens of young PhD students as well as professors using the Staff Exchange formula of Marie Skłodowska-Curie Actions "We are working on a sustainable and integrated approach to remove pollutants from contaminated water - explains Professor Paola Calza, project coordinator - and we are starting from a particular case study, aquaculture, for two reasons: its growing diffusion and the inevitable challenges that it poses in terms of exploiting water resources". Removing possible contaminants in the water, however, is not easy: "The biological, chemical and physical processes we are developing are intended precisely to remove organic compounds such as odorous substances, as well as metals. The next step will be to test the applicability and effectiveness of these technologies directly in real water treatment plants". ■

ACTIVITIES FOR STUDENTS

1. Experiments

Some other public engagement activities tailored for students were performed:

a. Target: secondary school students

SusWater Lab at University of Torino, Dept. Chemistry (14th February 2023). It was performed within the framework of **GWB2023-Global Women's Breakfast 2023-Breaking Barriers in Science**, organized by IUPAC, with the title "A *morning with SusWaterlab@UNITO*".
Target group: secondary school students.
Local SusWater team: Paola Calza, Debora Fabbri, Federica Spina, Enzo Laurenti, Mery Malandrino, Agnese Giacomino, Claudio Medana, Elisa Gaggero, Monica Rigoletto, Paolo Inaudi and Marco Sangermano

b. Target to high school students

A SusWater lab has been set up and has been presented by Paola Calza, Elisa Gaggero and Monica Rigoletto to high school students at UNITO during APERTAMENTE "ApertaMenteChimica", 13 -14 May 2022, University of Turin, Turin, Italy.
link: Frida_Apertamente, video available at Video_Apertamente

A laboratory practice targeted to a high school class within the framework of "Explora Project" was held on 30 March 2023 at the Department of Chemistry, University of Turin, Turin, Italy and presented by Mery Malandrino, Agnese Giacomino, Paolo Inaudi, Monica Rigoletto and Enzo Laurenti.

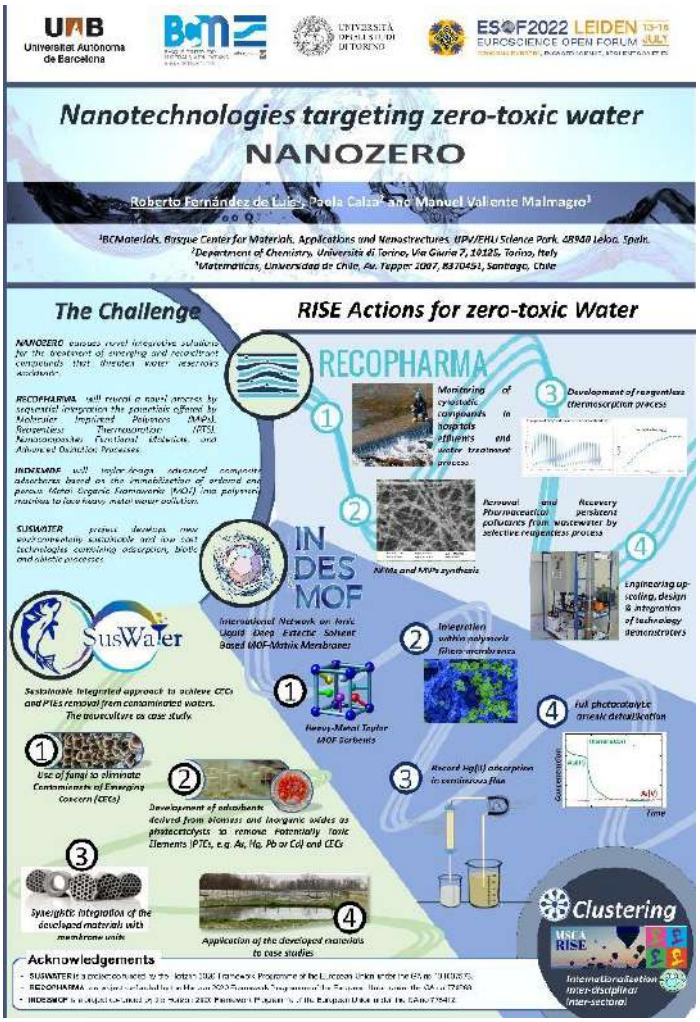
THE DISSEMINATION ACTIVITIES AIMED AT THE SCIENTIFIC COMMUNITY

1. Events

a. Joint presentations with other EU funded projects

1. **Giornata internazione della bioeconomia**
   24th September 2020 (online)
   ETN AQUAlity & SusWater: Interdisciplinary approach to achieve removal of contaminants from water using a green approach.
   P. Calza

2. **EuroScience Open Forum (ESOF**) 13th – 16th July 2022, Leiden, the Netherlands.
   Nanotechnologies targeting zero-toxic water (NANO ZERO)
   Interaction with RISE projects RECOPHARMA and INDESMOF
   Roberto Fernández de Luis, Paola Calza, Manuel Valiente Malmagro,



b. Organization of events

1. Winter School on ***Biological and Abiotic Transformation Processes for Removal of Pollutants in Water Systems***, 5-7 April 2022 - Campus de Móstoles, URJC, (Spain) organized by URJC with lesson delivered by member staff from URJC, UNITO, POLITO and AAU.

2. **SPEA11-11th European Conference on Solar Chemistry and Photocatalysis: Environmental Applications,** a conference organized by UNITO. It was the platform for share our results with the scientific community and for discussing future plan, thanks to the participation of staff members from UNITO, URJC, POLITO and KIT.

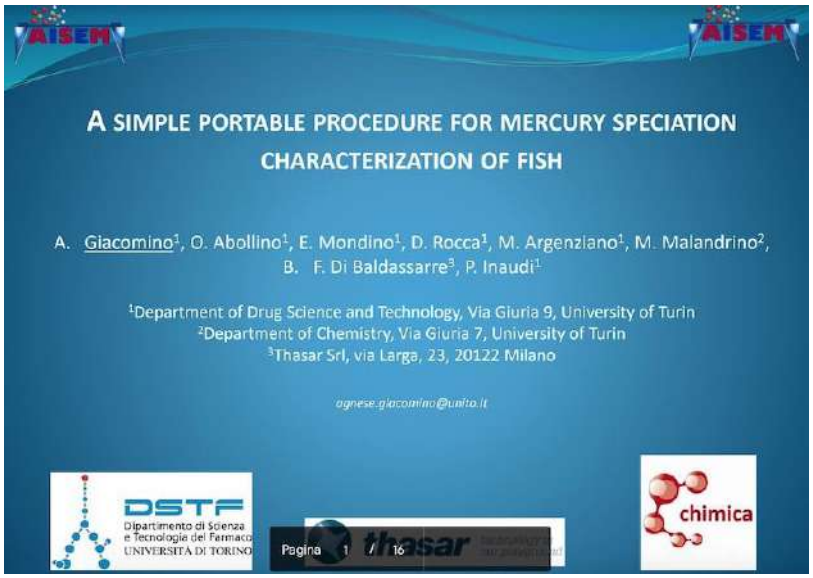
3. Workshop on ***Exploitation of Polymeric Hydrogels for wastewater remediation and biomedical applications*** 28th February-1st March 2023, Turin (Italy) - Politecnico di Torino organized by POLITO with lectures delivered by member staff from POLITO, URJC and UNITO.

2. Oral Communication

1. **XXVII Congresso Nazionale della Società Chimica Italiana (on-line)**
   14th-23rd September 2021, Rome (Italy)
   Removal of contaminants of emerging concern by enzymatic treatment with fungal laccases
   E. Gaggero, P. Calza, G .C. Varese b, F. Spina, M. Rigoletto, E. Laurenti (oral)

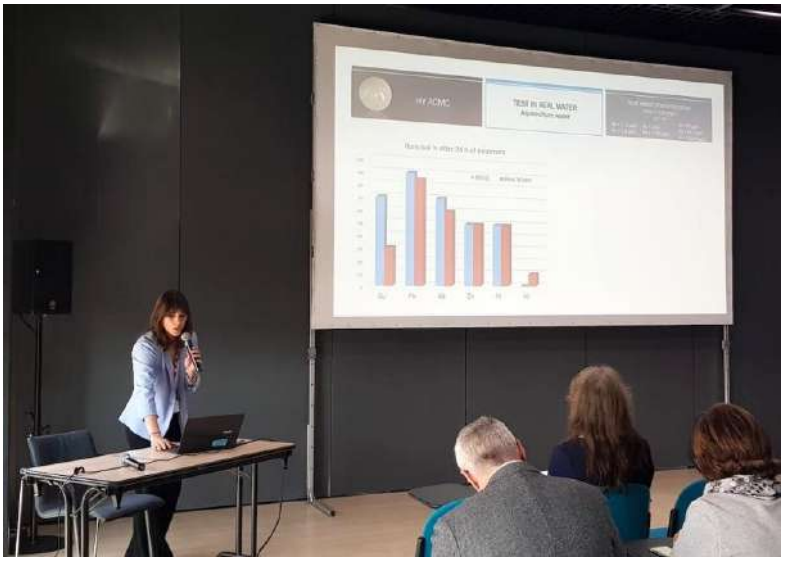
2. **MYCS 2021: Merck Young Chemists' Symposium**
   22nd-24th November 2021, Rimini (Italy)
   Photocatalytic removal of organic contaminants and mercury from aqueous solutions
   E. Gaggero, P. Calza, E. Bertozzi, M. C. Paganini, Erik Cerrato, M.-José López-Muñoz (oral)

3. **AISEM 2022: National Conference Sensors and Micro-Systems (on-line)**
   10th-11th February 2022, Rome (Italy)
   A simple portable procedure for mercury speciation characterization of fish
   A. Giacomino, O. Abollino, E. Mondino, D. Rocca, M. Argenziano, M. Malandrino, B. F. Di Baldassarre, P. Inaudi (oral)



4. **CMAT Webinar.**
   Abu Dhabi, 10th March 2022 (invited talk).
   Different strategies for restoring polluted environments.
   P. Calza

5. **JFIC2022: 10th edition of the Franco-Italian Days of Chemistry**
   Palais Neptune, Toulon, France April 26th and 27th, 2022
   Valorization of an agro-industrial waste: synthesis of soybean hulls derivatives-based hybrid materials for water purification.
   M. Rigoletto, V. Sederino, C. Camilleri Gioia, M. Malandrino, P. Calza, E. Laurenti (oral)



6. **SPEA11: 11th European Conference on Solar Chemistry and Photocatalysis: Environmental Applications**

Palazzo Città Metropolitana, Turin (Italy), June 6th-10th, 2022

Enhancing the photocatalytic activity of graphitic carbon nitrides by tuning synthesis variables for the degradation of methylparaben.

J. Plaza, A. Arencibia, E. Parra, M. M. González, M.-J. López-Muñoz (oral)

Photocatalytic improvement of graphitic carbon nitride materials by iron incorporation in a one-step synthesis.

A. Arencibia, E. Parra, J. Plaza, M.-J. López-Muñoz (Flash oral communication)

Robust metal oxides as ZrO2 doped with cerium, nitrogen and copper for photodegradation of pollutants in water.
M.C. Paganini, E. Cerrato Erik, M. Spallone, P. Calza, D. Fabbri (oral)

7. **8th International Workshop on Layered & Nanostructured materials.**
   Toledo (Spain), 10th -13th July, 2022.
   Exfoliated graphitic carbon nitride nanosheets for heterogeneous visible light photocatalysis.
   A. Arencibia, J. Plaza, E. Parra, M. M. González M.-J. López-Muñoz Plaza Jorge.

8. **XIX National Congress of the Environmental and Cultural Heritage Division of the Italian Chemical Society**
   Turin (Italy) - June 20th-23rd, 2022
   Development of innovative strategies for pollutants abatement in aquaculture systems.
   E. Gaggero, A. Italiano, M. C. Paganini, G. C. Varese, F. Spina, P. Calza (oral)

Characterization and monitoring of UV filters in sunscreens by voltammetric methods.

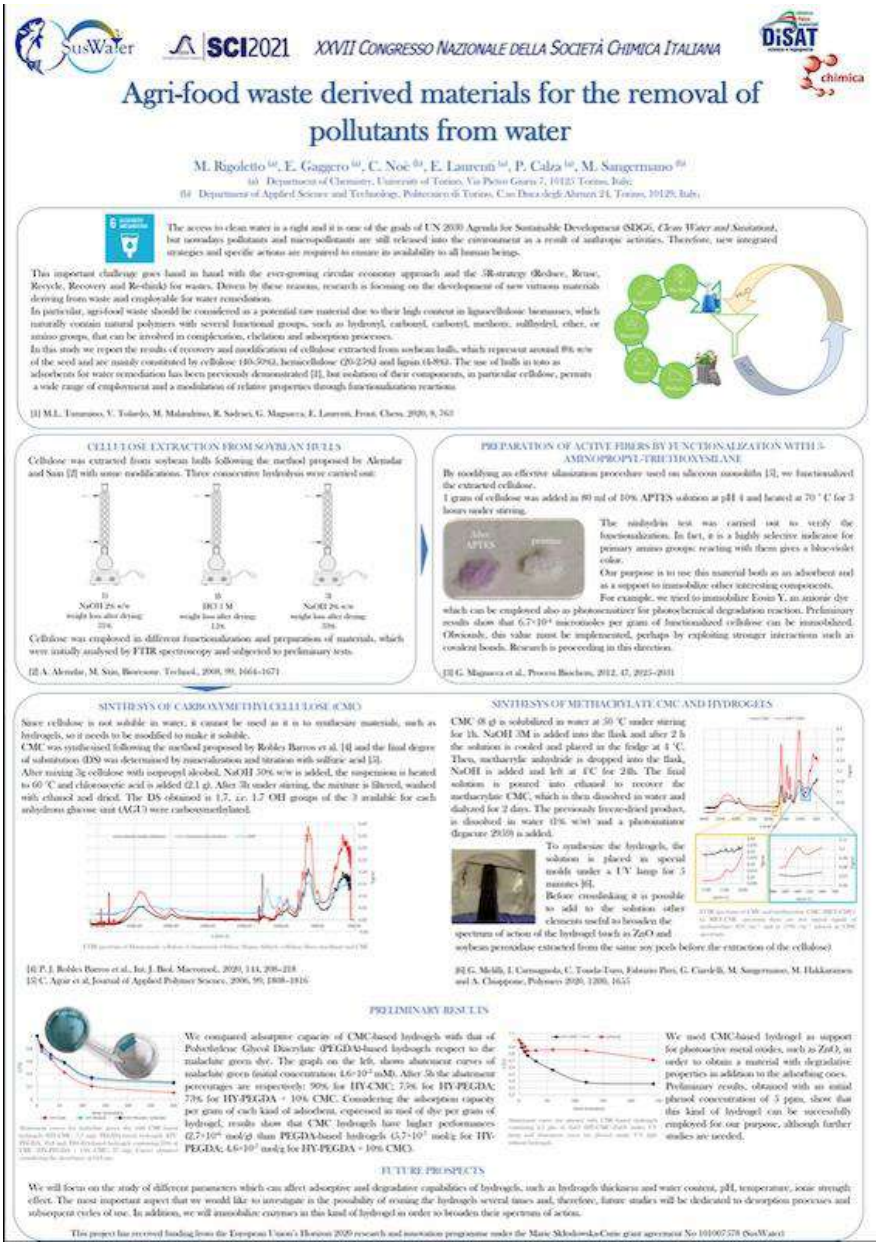
P. Inaudi, L. Favilli, A. Diana, S. Bertinetti, M. Malandrino, O. Abollino, M. Rocci, A. Giacomino

3. Poster Communication

1. XXVII Congresso Nazionale della Società Chimica Italiana (on-line)

14th-23rd September 2021, Rome (Italy)

Agri-food waste derived materials for the removal of pollutants from water.
M. Rigoletto, E. Gaggero, C. Noè, E. Laurenti, P. Calza, M. Sangermano
(poster)



SusWater SCI2021 XXVII Congresso Nazionale della Società Chimica Italiana DiSAT chimica

Agri-food waste derived materials for the removal of pollutants from water

M. Rigoletto [a], E. Gaggero [a], C. Noè [b], E. Laurenti [a], P. Calza [a], M. Sangermano [b]

[a] Department of Chemistry, University of Torino, Via Pietro Giuria 7, 10125 Torino, Italy;
[b] Department of Applied Science and Technology, Politecnico di Torino, Corso Duca degli Abruzzi 24, Torino, 10129, Italy.

The access to clean water is a right and it is one of the goals of UN 2030 Agenda for Sustainable Development (SDG6, *Clean Water and Sanitation*), but nowadays pollutants and micropollutants are still released into the environment as a result of anthropic activities. Therefore, new integrated strategies and specific actions are required to ensure its availability to all human beings.

This important challenge goes hand in hand with the ever-growing circular economy approach and the 5R-strategy (Reduce, Reuse, Recycle, Recovery and Re-think) for wastes. Driven by these missions, research is focusing on the development of new virtuous materials deriving from waste and employable for water remediation.
In particular, agri-food waste should be considered as a potential raw material due to their high content in lignocellulosic biomasses, which naturally contain natural polymers with several functional groups, such as hydroxyl, carbonyl, carboxyl, methoxy, sulfhydryl, ether, or amino groups, that can be involved in complexation, chelation and adsorption processes.
In this study we report the results of recovery and modification of cellulose extracted from soybean hulls, which represent around 8% w/w of the seed and are mainly constituted by cellulose (40-50%), hemicellulose (20-25%) and lignin (4-8%). The use of hulls in toto as adsorbents for water remediation has been previously demonstrated [1], but isolation of their components, in particular cellulose, permits a wide range of employment and a modulation of relative properties through functionalization reactions.

[1] M.L. Tummino, V. Tolardo, M. Malandrino, R. Sadeiro, G. Magnacca, E. Laurenti, Front. Chem. 2020, 8, 263

CELLULOSE EXTRACTION FROM SOYBEAN HULLS

Cellulose was extracted from soybean hulls following the method proposed by Alemdar and Sain [2] with some modifications. Three consecutive hydrolysis were carried out:

i) NaOH 2% w/v, weight loss after drying: 35%
ii) HCl 1 M, weight loss after drying: 12%
iii) NaOH 2% w/v, weight loss after drying: 30%

Cellulose was employed in different functionalization and preparation of materials, which were initially analysed by FTIR spectroscopy and subjected to preliminary tests.

[2] A. Alemdar, M. Sain, Bioresour. Technol., 2008, 99, 1664-1671

PREPARATION OF ACTIVE FIBERS BY FUNCTIONALIZATION WITH 3-AMINOPROPYL-TRIETHOXYSILANE

By modifying an effective silanization procedure used on silicon nanofibrils [3], we functionalized the extracted cellulose.
1 grams of cellulose was added in 80 ml of 10% APTES solution at pH 4 and heated at 70 °C for 3 hours under stirring.

After APTES / pristine

The ninhydrin test was carried out to verify the functionalization. In fact, it is a highly selective indicator for primary amino groups: reacting with them gives a blue-violet color.
Our purpose is to use this material both as an adsorbent and as a support to immobilize other interesting components.
For example, we tried to immobilize Eosin Y, an anionic dye which can be employed also as photocatalyst for photochemical degradation reaction. Preliminary results show that $6.7 \cdot 10^{-4}$ micromoles per gram of functionalized cellulose can be immobilized. Obviously, this value must be implemented, perhaps by exploiting stronger interactions such as covalent bonds. Research is proceeding in this direction.

[3] G. Magnacca et al., Process Biochem, 2012, 47, 2025-2031

SINTHESYS OF CARBOXYMETHYLCELLULOSE (CMC)

Since cellulose is not soluble in water, it cannot be used as it is to synthesize materials, such as hydrogels, so it needs to be modified to make it soluble.
CMC was synthesised following the method proposed by Robles Barros et al. [4] and the final degree of substitution (DS) was determined by mineralization and titration with sulfuric acid [5].
After mixing 3g cellulose with isopropyl alcohol, NaOH 50% w/w is added, the suspension is heated to 60 °C and chloroacetic acid is added (2.1 g). After 3h under stirring, the mixture is filtered, washed with ethanol and dried. The DS obtained is 1.7, *i.e.* 1.7 OH groups of the 3 available for each anhydrous glucose unit (AGU) were carboxymethylated.

FTIR spectrum of Microcrystalline Cellulose, Sodium Chloroacetate, Dried Raw Material and CMC

[4] P. J. Robles Barros et al., Int. J. Biol. Macromol., 2020, 144, 208–218
[5] C. Agrar et al, Journal of Applied Polymer Science, 2006, 99, 1808–1816

SINTHESYS OF METHACRYLATE CMC AND HYDROGELS

CMC (8 g) is solubilized in water at 50 °C under stirring for 1h. NaOH 3M is added into the flask and after 2 h the solution is cooled and placed in the fridge at 4 °C. Then, methacrylic anhydride is dropped into the flask. NaOH is added and left at 4°C for 24h. The final solution is poured into ethanol to recover the methacrylate CMC, which is then dissolved in water and dialyzed for 2 days. The previously freeze-dried product, is dissolved in water (1% w/w) and a photoinitiator (Irgacure 2959) is added.

To synthesize the hydrogels, the solution is placed in special molds under a UV lamp for 5 minutes [6].
Before crosslinking it is possible to add to the solution other elements useful to broaden the spectrum of action of the hydrogel (such as ZnO and soybean peroxidase extracted from the same soy peels before the extraction of the cellulose)

FTIR spectrum of CMC and Methacrylate CMC (MET-CMC)

[6] G. Melilli, I. Carmagnola, C. Tonda-Turo, Fabrizio Pirri, G. Ciardelli, M. Sangermano, M. Hakkarainen and A. Chiappone, Polymers 2020, 12(8), 1655

PRELIMINARY RESULTS

We compared adsorptive capacity of CMC-based hydrogels with that of Polyethylene Glycol Diacrylate (PEGDA)-based hydrogels respect to the malachite green dye. The graph on the left, shows abatement curves of malachite green (initial concentration $4.6 \cdot 10^{-5}$ mM). After 5h the abatement percentages are respectively: 90% for HY-CMC; 7.9% for HY-PEGDA; 73% for HY-PEGDA + 10% CMC. Considering the adsorption capacity per gram of each kind of adsorbent, expressed in mol of dye per gram of hydrogel, results show that CMC hydrogels have higher performances ($2.7 \cdot 10^{-6}$ mol/g than PEGDA-based hydrogels ($5.7 \cdot 10^{-7}$ mol/g for HY-PEGDA; $4.6 \cdot 10^{-7}$ mol/g for HY-PEGDA + 10% CMC).

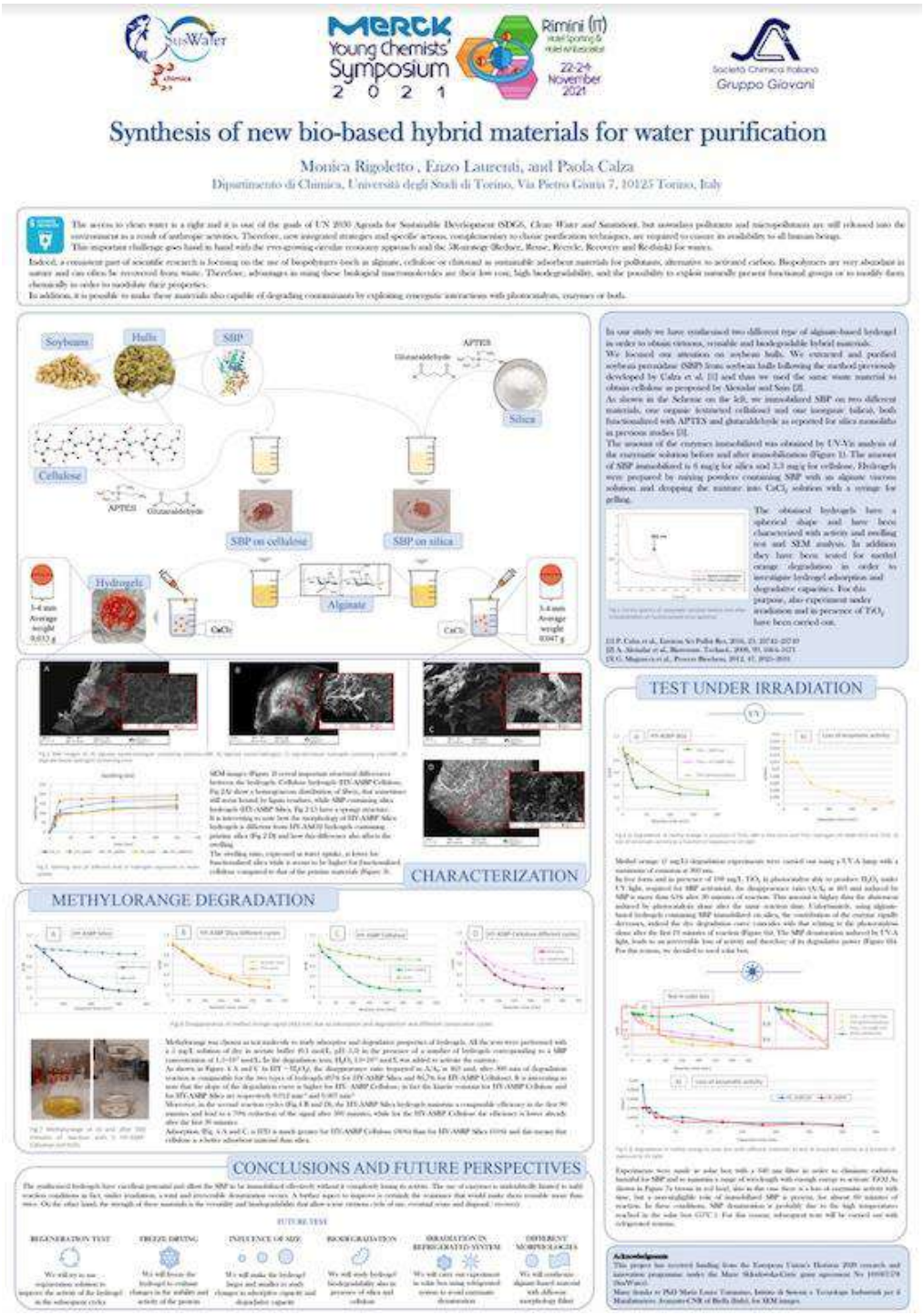
We used CMC-based hydrogel as support for photoactive metal oxides, such as ZnO, in order to obtain a material with degradative properties in addition to the adsorbing ones. Preliminary results, obtained with an initial phenol concentration of 5 ppm, show that this kind of hydrogel can be successfully employed for our purpose, although further studies are needed.

FUTURE PROSPECTS

We will focus on the study of different parameters which can affect adsorptive and degradative capabilities of hydrogels, such as hydrogels thickness and water content, pH, temperature, ionic strength effect. The most important aspect that we would like to investigate is the possibility of reusing the hydrogels several times and, therefore, future studies will be dedicated to desorption processes and subsequent cycles of use. In addition, we will immobilize enzymes in this kind of hydrogel in order to broaden their spectrum of action.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 101007578 (SusWater)

2. **MYCS 2021: Merck Young Chemists' Symposium**
   22nd-24th November 2021, Rimini (Italy)
   Synthesis of new bio-based hybrid materials for water purification.
   M. Rigoletto , E. Laurenti, P. Calza (poster)



3. **Euromembrane**
   Copenhagen, 28th November -2nd December **2021**
   Preparation of High-Performance Porous Zeolite-Silica Membranes for Water Desalination.
   X. Chen, V. Boffa, Y. Yue
4. **AISEM 2022: National Conference Sensors and Micro-Systems (on-line)**

10th-11th February 2022, Rome (Italy)
Monitoring uv filters through the use of voltammetric methods.
P. Inaudi, O. Abollino, M. Malandrino, E. Botticella, A. Giacomino (poster)

XXI Conferenza Nazionale Sensori e Microsistemi (AISEM 2022)
Roma, 10/11 Febbraio 2022

MONITORING UV FILTERS THROUGH THE USE OF VOLTAMMETRIC METHODS

Inaudi, Paolo (1); Abollino, Ornella (1); Malandrino, Mery (2); Botticella, Elena (1) Giacomino, Agnese (1)

(1) Department of Drug Science and Technology, University of Turin, Italy; (2) Department of Chemistry, University of Turin, Italy

INTRODUCTION

Sunscreens are very useful since they protect the skin against radiations.
However, some chemical sun-blocking agents can be almost as damaging as UV radiation itself, making the effects of some sunscreens questionable, for these reasons it is very important to control their effectiveness, safety and to monitor their release into the environment, as they are now considered as contaminants of emerging concern (CEC).

METHODS

-Analytical technique -

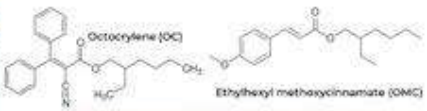
Carbon Paste Electrodes (CPEs) obtained mixing graphite powder and an aliquot of sunscreen were used as working electrodes. The redox anodic and cathodic profiles of the investigated sunscreens were recorded by square wave voltammetry (SWV). Subsequently, the resistance of products to exposure to sunlight was tested using a solar box. Voltammograms were recorded after different exposure times.
A glassy carbon electrode (GCE) was also used for check the presence of UV filters in different products.
0.5 g of each sample were mixed with 16mL of 0.04 M Britton Robinson buffer and 4 mL of ethanol.
The effect of the addition of 6mM cetyltrimethylammonium bromide (CTAB) to the solution the sensitivity of the analysis was demonstrated.
0.5 g of samples were added to 20 mL of seawater to test the applicability of the method on a real samples.
The analysis was performed by a PGSTAT 10 potentiostat (Eco Chemie, Utrecht, the Netherlands) coupled to a 663 VA Metrohm (Herisau, Switzerland) stand.
The potentiostat was interfaced to a personal computer and the software GPES 4.9 was used.

OBJECTIVES

The present work aims evaluating the applicability of voltammetry
- to check sunscreen quality and composition
- to check the presence of residues of sunscreen agent in seawater

-Samples and analytes -

UV filters octocrylene (OC) and ethylhexyl methoxycinnamate (OMC) were determined in different sunscreens purchased in pharmacies and supermarkets in the province of Turin.



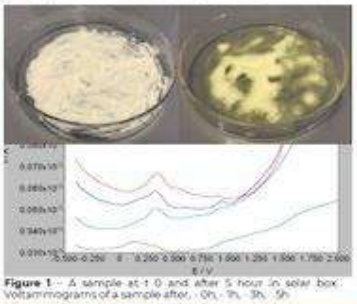


Figure 1 - A sample at t 0 and after 5 hour in solar box. Voltammograms of a sample after: - 0h; - 1h; - 3h; - 5h

STEPS OF INVESTIGATION

Before proceeding with the analysis of sunscreens, tests were carried out on standard solutions of OC in 20 mL of Britton Robinson buffer-ethanol 80:20 solution to assess the response and the performance of the technique.
The stability of the sunscreen was tested by analyzing it with voltammetry after increasing times of exposure to sunlight in a solar box. The use of CTAB to improve analytical performance of the method was tested.
Sunscreen in seawater sample was analyzed.
Comparison between different products were made.

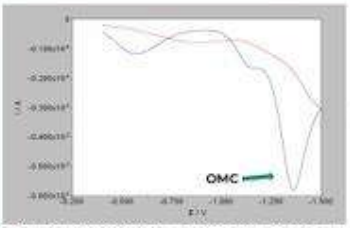


Figure 2 - Voltammogram of a sunscreen containing OMC in presence of CTAB (-) and without CTAB (--)

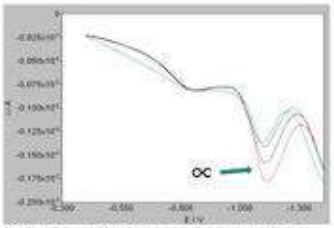


Figure 3 - Determination of OC in sample of seawater with three additions of OC standard

RESULTS

The results obtained so far have allowed us to see how the concentration of UV filters decreases after several hours of exposure to the solar box and that this can be determined by SWV using CPE. Figure 1 shows the modification of a product after 5 hours in solar box and the relative voltammograms.
CTAB has proven to be an excellent supporting electrolyte for this type of analysis, thanks to the increase of the response sensitivity (Figure 2). Tests by dissolving samples in seawater (Figure 3) have allowed us to understand that it is possible to apply SWV with GCE to monitor the residues of this substances in water ecosystems.
Voltammetry has proved to be an excellent technique also to compare different products containing different UV filters (Figure 4) to assess their quality and stability, for human safety purposes. In conclusion, the technique showed good potentialities for sunscreen analysis thanks to its low costs, ease of use and the possibility of carrying out measurements even on site.

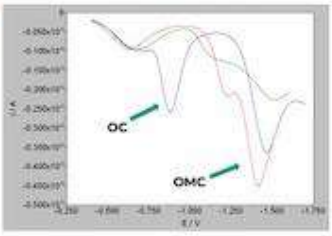


Figure 4 - Voltammogram of three different commercial sunscreens. -- OMC and OC, - OMC, · without UV filters

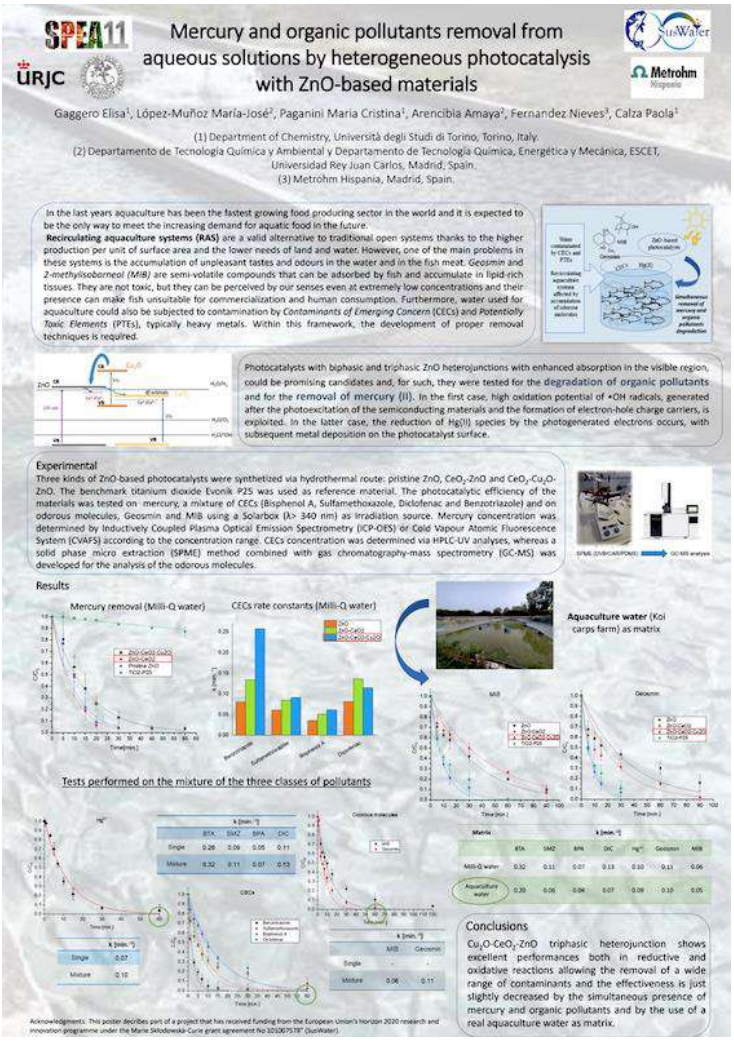
DSTF Dipartimento di Scienza e Tecnologia del Farmaco UNIVERSITÀ DI TORINO

Progetto: Proof of Concept (PoC)
TOINPROVE/2020
MISTICA

SusWater

5. **META 2022: XIV Congreso Español de Tratamiento de Aguas**
   Sevilla (España), 1st -3td June, 2022.
   Síntesis de nitruros de carbono grafíticos para la reducción fotocatalítica de Hg(II) en aguas .
   B. Villajos, A. Arencibia, M. J. López-Muñoz.

6. **SPEA11: 11th European Conference on Solar Chemistry and Photocatalysis: Environmental Applications**
   Palazzo Città Metropolitana, Turin (Italy) - June 6th-10th, 2022
   Mercury and organic pollutants removal from aqueous solutions by heterogeneous photocatalysis with ZnO-based materials.
   E. Gaggero, M.-J. López-Muñoz, M. C. Paganini, A. Arencibia, N. Fernandez, P. Calza (poster)



Photocatalytic Degradation of Methylisothiazolinone in Water by TiO_2 and TiO_2/Persulfate Activation with Simulated Solar Radiation.
P. Gómez-Rodríguez, D. Fabbri, P. Calza, D. Revelli, R. van-Grieken, M.J. López-Muñoz

7. **XIX National Congress of the Environmental and Cultural Heritage Division of the Italian Chemical Society**
Turin (Italy) - June 20th-23rd, 2022
Use of waste materials to remove organic contaminants from water.
P. Calza, V. Sederino, D. Fabbri, M. Rigoletto, E. Laurenti

8. **GEI2022 Giornate dell'Elettrochimica Italiana**
Orvieto (Italy), 11th -14th September 2022
Voltammetric methods for monitoring UV filters in sunscreens.
P. Inaudi, M. Rocci, L. Favilli, A. Diana, S. Bertinetti, M. Malandrino, O. Abollino, A. Giacomino

COMPLETE CITATION OF THE DISSEMINATION ACTIVITIES AIMED AT THE SCIENTIFIC COMMUNITY

17 research papers published, accepted or submitted for publication in peer-reviewed international journals and **3 in preparation**:

a. Publications on peer reviewed journals

1. Camilla Noè, Andrea Cosola, Annalisa Chiappone, Minna Hakkarainen, Hansjorg ¨ Grützmacher, Marco Sangermano, From polysaccharides to UV-curable biorenewable organo/hydrogels for methylene blue removal, Polymers 235 (2021) 124257

2. Jorge Plaza, Amaya Arencibia, María José López-Muñoz, Evaluation of nZVI for the degradation of atrazine in heterogeneous Fenton-like systems at circumneutral pH, Journal of Environmental Chemical Engineering, 9, 106641, 2021, 10.1016/j.jece.2021.106641

3. Camilla Noè, Michael Zanon, Amaya Arencibia, María-José López-Muñoz, Nieves Fernández de Paz, Paola Calza and Marco Sangermano, UV-Cured Chitosan and Gelatin Hydrogels for the Removal of As(V) and Pb(II) from Water, Polymers 2022, 14, 1268. https://doi.org/10.3390/polym14061268

4. Paolo Inaudi, Elio Mondino, Ornella Abollino, Mery Malandrino, Monica Argenziano, Laura Favilli, Roberto Boschini and Agnese Giacomino, On-Site Determination of Methylmercury by Coupling Solid-Phase Extraction and Voltammetry, Molecules, 2022, 27, 3178. https://doi.org/10.3390/molecules27103178

5. Vittorio Boffa, Debora Fabbri, Paola Calza, Delia Revelli, Peter Vittrup Christensen, Potential of nanofiltration technology in recirculating aquaculture systems in a context of circular economy, Chemical Engineering Journal Advances 10 (2022) 100269, https://doi.org/10.1016/j.ceja.2022.100269

6. Erik Cerrato, Elisa Gaggero, Paola Calza, Maria Cristina Paganini, The role of Cerium, Europium and Erbium doped TiO_2 photocatalysts in water treatment: A mini-review, Chemical Engineering Journal Advances 10 (2022) 100268, https://doi.org/10.1016/j.ceja.2022.100268

7. Elisa Gaggero, Paola Calza, Erik Cerrato and Maria Cristina Paganini, Cerium-, Europium- and Erbium-Modified ZnO and ZrO_2 for Photocatalytic Water Treatment Applications: A Review, Catalysts 2021, 11, 1520. https://doi.org/10.3390/catal11121520

8. Monica Rigoletto, Paola Calza, Elisa Gaggero, Enzo Laurenti, Hybrid materials for the removal of emerging pollutants in water: classification, synthesis, and properties, Chemical Engineering Journal Advances 10 (2022) 100252

9. Erik Cerrato, Mario Chiesa, Elio Giamello, Stefano Livraghi, Enrico Salvadori and

Maria Cristina Paganini, Zinc oxide hollow spheres decorated with cerium dioxide. The role of morphology in the photoactivity of semiconducting oxides, J. Phys.: Condens. Matter 34 (2022) 134001.

10. Erik Cerrato, Alberto Privitera, Mario Chiesa, Enrico Salvadori and Maria Cristina Paganini, Nitrogen-Doped Zinc Oxide for Photo-Driven Molecular Hydrogen Production, Int. J. Mol. Sci. 2022, 23, 5222. https://doi.org/10.3390/ijms23095222

11. Marco Sangermano, Antonio Grieco, Camilla Noè, and Giancarlo Rizza, UV-Cured PDMS for Oil Removal from Wastewater, Macromol. Chem. Phys. 2022, 2200345, DOI: 10.1002/macp.202200345.

12. Rossella Sesia, Sara Ferraris, Marco Sangermano and Silvia Spriano, UV-Cured Chitosan-Based Hydrogels Strengthened by Tannic Acid for the Removal of Copper Ions from Water, Polymers, 2022, 14, 4645. https://doi.org/10.3390/polym14214645.

13. Pilar Gómez-Rodríguez, Paola Calza, Debora Fabbri, Claudio Medana, Rafael van-Griekena, María-José López-Muñoz Photocatalytic Degradation of Methylisothiazolinone in Water by TiO_2 and TiO_2/Persulfate systems with Simulated Solar Radiation, Catalysis Today, 413-415 (2023) 113942

b. Papers accepted

1. Gaggero Elisa, López-Muñoz María-José, Paganini Maria Cristina, Arencibia Amaya, Mery Malandrino, Fernandez Nieves, Calza Paola, Mercury and organic pollutants removal from aqueous solutions by heterogeneous photocatalysis with ZnO-based materials, Molecules, in press

2. Monica Rigoletto, Paola Calza, Alexandre Santuchi da Cunha, Valentina Sederino, Debora Fabbri, Maria Laura Tummino, Enzo Laurenti, Soybean peroxidase immobilised on cellulose-alginate hydrogels for removal of recalcitrant organic pollutants in water, under submission on Reaction Chemistry & Engineering.

c. Papers under revision

1. Z. Teng, H. Yang, Q. Zhang, W. Cai, YR. Lu, K. Kato, Z. Zhang, H. Sun, S. Liu, C. Wang, P. Chen, A. Yamakata, C. Su, B. Liu, T. Ohno, Atomically Dispersed d10 s-block Au Boosts Photocatalytic 1e-Water Oxidation for Self-Cleaning, Sanitation and Safe Drinkable Water, under submission on **Nature Nanotechnology**

2. H. Yang, L. Jia, B. Xu, Y. Wang, Q. Zhang, Z. Nan, M. Zhang, T. Ohno, Constructing isogenous CeO2/Ce-MOF S-scheme heterojunctions for photocatalytic removal of acetaldehyde under visible light, under submission on **Environmental Science & Technology**

d. Papers under preparation

1. Jorge Plaza, Amaya Arencibia, María José López-Muñoz, Optimization of thermal exfoliation process in graphitic carbon nitride materials for methylparaben

degradation

2. Beatriz Villajos, Amaya Arencibia, María José López-Muñoz, Influence of the synthesis parameters on the photocatalytic performance of g-C3N4 for Hg(II) removal from water

3. Xinxin Chen, Vittorio Boffa, Xianzheng Ma, Giuliana Magnacca, Paola Calza, Deyong Wang, Francesca Deganello, Antonio Comite, Yuanzheng Yue, MOF-based nanocomposite membrane for the treatment of wastewater and aquaculture effluents

25 Presentations as orals or posters to conferences and workshops

a. Orals

a1. Orals presented at international conferences.

1. P. Calza, ***Different strategies for restoring polluted environments***, Abu Dhabi, CMAT Webinar, 10th March 2022 (invited talk).

2. Rigoletto M, Sederino V., Camilleri Gioia C., Malandrino M., Calza P., Laurenti E., "***Valorization of an agro-industrial waste: synthesis of soybean hulls derivatives-based hybrid materials for water purification***" Xth Franco-Italian Days of Chemistry, Toulon 26-27 April **2022**.

3. Plaza Jorge, Arencibia Amaya, Parra Elena, González Marta María, López-Muñoz María-José, "***Enhancing the photocatalytic activity of graphitic carbon nitrides by tuning synthesis variables for the degradation of methylparaben***", SPEA 11: 11th European Conference on Solar Chemistry and Photocatalysis: Environmental Applications, Turin (Italy), 6-10 June, 2022.

4. Arencibia Amaya, Plaza Jorge, Parra Elena, González Marta-María, López-Muñoz María-José, "***Exfoliated graphitic carbon nitride nanosheets for heterogeneous visible light photocatalysis***", 8th Int Workshop on Layered & Nanoestructured materials, Toledo (Spain) 10 -13 July 2022.

5. Arencibia, A., Elena Parra, E., Jorge Plaza, J., López-Muñoz M.J, "***Photocatalytic improvement of graphitic carbon nitride materials by iron incorporation in a one-step synthesis***", Flash oral communication, SPEA 11: 11th European Conference on Solar Chemistry and Photocatalysis: Environmental Applications, Turin (Italy), 6-10, June 2022.

6. MC Paganini, E. Cerrato, D. Fabbri, P. Calza, SPEA 11: 11th European Conference on Solar Chemistry and Photocatalysis: Environmental Applications, Turin (Italy), 6-10 June 2022

7. Plaza J., Arencibia A., Parra E., González M. M., López-Muñoz M.J., ***Exfoliated graphitic carbon nitride nanosheets for heterogeneous visible light photocatalysis,*** 8th Int Workshop on Layered & Nanoestructured materials, Toledo (Spain), 10-13 July, 2022.

8. M.J. López-Muñoz, B. Villajos, A. Arencibia, ***Influence of the synthesis parameters on the photocatalytic performance of g-C_3N_4 for Hg(II) removal from water,*** 5th Iberoamerican Conference on Advanced Oxidation Technologies (CIPOA 5th), Cusco (Perú), 7-11 November, 2022.

9. X. Chen, V. Boffa, Y. Yue, ***POROUS ZIF8-SiO_2 NANO-FILTRATION MEMBRANES FOR WATER PURIFICATION***, Euromembrane, Sorrento, 22-24 November **2022**

a2. Orals presented at national conferences.

1. E . Gaggero, P. Calza, G .C. Varese, F. Spina, M .Rigoletto, E . Laurenti***, Removal of contaminants of emerging concern by enzymatic treatment with fungal laccases***, Conference SCI 2021, 14-23 September **2021** (on line)
2. Elisa Gaggero, Paola Calza, Erica Bertozzi, Maria Cristina Paganini, Erik Cerrato, and María-José López-Muñoz, ***Photocatalytic removal of organic contaminants and mercury from aqueous solutions***, Merck Young Chemists' Symposium (MYCS) 2021, 22-24 November 2021.

3. P. Inaudi, L. Favilli, A. Diana, S. Bertinetti, M. Malandrino, O. Abollino, M. Rocci, A. Giacomino, ***Characterization and monitoring of UV filters in sunscreens by voltammetric methods***, XIX Congresso Nazionale della Divisione di Chimica dell'Ambiente e dei Beni Culturali - Torino, 20 - 23 June **2022**

4. A. Giacomino, O. Abollino, E. Mondino, D. Rocca, M. Argenziano, M. Malandrino, B. F. Di Baldassarre, P. Inaudi, ***A SIMPLE PORTABLE PROCEDURE FOR MERCURY SPECIATION CHARACTERIZATION OF FISH***, XXI Conferenza Nazionale Sensori e Microsistemi (AISEM 2022) - Rome, 10/11 February **2022** (On-line)

5. E. Gaggero, A. Italiano, M. C. Paganini, G. C. Varese, F. Spina and P. Calza, ***DEVELOPMENT OF INNOVATIVE STRATEGIES FOR POLLUTANTS ABATEMENT IN AQUACULTURE SYSTEMS***, XIX Congresso Nazionale della Divisione di Chimica dell'Ambiente e dei Beni Culturali - Torino, 20 - 23 June **2022.**

b. Posters

b1. Posters presented at international conferences

1. Chen Xinxin, Boffa Vittorio, Yue Yuanzheng, Preparation of High-Performance ***Porous Zeolite-Silica Membranes for Water Desalination***, Euromembrane, Copenhagen, 28 November -2 December **2021**

2. Gaggero Elisa, López-Muñoz María-José, Paganini Maria Cristina, Arencibia Amaya, Fernandez Nieves, Calza Paola, ***Mercury and organic pollutants removal from aqueous solutions by heterogeneous photocatalysis with ZnO-based materials***, SPEA11 Turin, 6-10 June **2022**

3. Gómez-Rodríguez P., Fabbri D., Calza P., Revelli D., van-Grieken R, López-Muñoz M.J**.,** ***Photocatalytic Degradation of Methylisothiazolinone in Water by TiO_2 and TiO_2/Persulfate Activation with Simulated Solar Radiation***, SPEA11, Turin, 6-10 June **2022**

4**.** B. Villajos, M.J. López-Muñoz, A. Arencibia, ***Síntesis de carbones a partir de lignina para la adsorción de metales pesados***, LXII Reunión Ibérica de Adsorción, Valencia (Spain) 13-16 September **2022**.

5. M.J. López-Muñoz, J. Plaza, P. Bonilla, A. Arencibia, ***Evaluation of quantitative estimation of hydroxyl radicals production by exfoliated g-C_3N_4 materials in solar photocatalytic processes***, 5th Iberoamerican Conference on Advanced Oxidation Technologies (CIPOA 5th), Cusco (Perú), 7-11 November, **2022**.

b2. Posters presented at national conferences.

1. M. Rigoletto, E. Gaggero, C. Noè, E. Laurenti, P. Calza, M. Sangermano, "***Agri-food waste derived materials for the removal of pollutants from water***" Conference SCI 2021, 14-23 September **2021**

2. Monica Rigoletto, Enzo Laurenti, and Paola Calza, ***Synthesis of new bio-based hybrid materials for water purification***" Merck Young Chemists' Symposium (MYCS) 2021, 22-24 November 2021"
3. Inaudi, Paolo; Abollino, Ornella; Malandrino, Mery; Botticella, Elena, Giacomino, Agnese, MONITORING UV FILTERS THROUGH THE USE OF VOLTAMMETRIC METHODS XXI Conferenza Nazionale Sensori e Microsistemi (AISEM 2022) - Rome, 10/11 February **2022** (On-line)

4. P. Calza, V. Sederino, D. Fabbri, M. Rigoletto, E. Laurenti, ***USE OF WASTE MATERIALS TO REMOVE ORGANIC CONTAMINANTS FROM WATER***, XIX Congresso Nazionale della Divisione di Chimica dell'Ambiente e dei Beni Culturali - Turin, 20 - 23 June **2022**

5. B. Villajos, A. Arencibia y M. J. López-Muñoz, "***Síntesis de nitruros de carbono grafíticos para la reducción fotocatalítica de Hg(II) en aguas"***, META 2022: XIV Congreso Español de Tratamiento de Aguas, Sevilla (España), 1 -3 June, **2022**.

6. P. Inaudi, M. Rocci, L. Favilli, A. Diana, S. Bertinetti, M. Malandrino, O. Abollino, A. Giacomin, ***Voltammetric methods for monitoring UV filters in sunscreens***, GEI2022 Giornate dell'Elettrochimica Italiana, Orvieto 11-14 September **2022**.