

Interuniversity Research Center



# HTR - Interuniversity Research Center

High Tech Recycling Research Center (HTR) is an interuniversity research center joining the University of Rome La Sapienza (location of the center at the Department of Chemistry), the University of L'Aquila, the Polytechnic of Marche, the University of Genoa, the University of Cagliari and the Institute of Environmental Geology and Geoengineering of the National Research Council.

Founded in 2007, HTR promotes the development of sustainable processes for the treatment of e-wastes and agro-industrial by-products. Developed processes aim at the recovery of secondary raw materials according to circular economy approach.

HTR is participating in several research projects funded by IT government and EU commission in partnership with universities and industrial companies.



## Activities

Development of innovative hydrometallurgical processes for the recycling of technological wastes.

Development of innovative biotechnological processes for fine chemical production.

Development of innovative products (bioadsorbent materials, nanostructured metal-based materials).

Technical-economic feasibility and environmental impact assessment (LCA).



## Research Staff

20 researchers from the different universities putting together their skills in industrial chemistry, biotechnology and chemical engineering towards the goal of economic and environmental sustainability

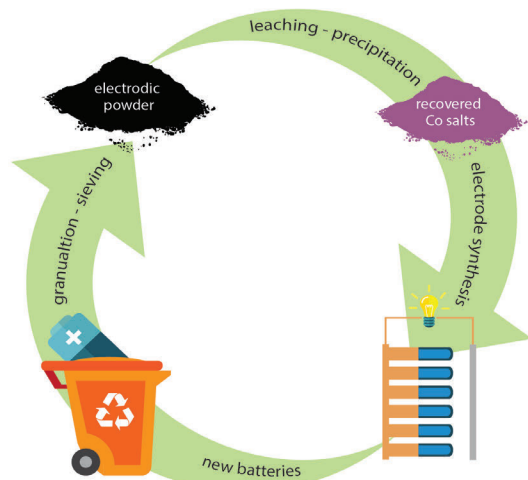
Director: Prof. Francesca Pagnanelli

# Electronic waste treatment

HTR researchers developed different processes for the treatment of e-wastes such as batteries, accumulators and photovoltaic panels.

## Batteries - Accumulators

Main objective in the treatment of batteries and **Li-ion** accumulators has been the development of **zero-waste** processes in which each element is separated and recycled for the production of new storage devices<sup>[1]</sup>



## A new view

The experience gained and the growing heterogeneity of Li-ion accumulators led HTR researchers towards an advanced approach: the complexity of batteries is exploited to obtain **innovative nano-materials avoiding complex separation** operations and improving process sustainability<sup>[2]</sup>



## Financed Projects



First of a kind commercial Compact system for the efficient Recovery Of COBalt Designed with novel Integrated LEADING technologies. H2020-SC5-2016-2017 - 2018-2022 (Subcontractor) <https://h2020-crocodile.eu/>



innovative Hydrometallurgical Processes to recover Metals from WEEE including lamps and batteries: Demonstration. European Community's Seventh Framework Program. 2012-2016 (Partner) [http://cordis.europa.eu/result/rcn/158626\\_en.html](http://cordis.europa.eu/result/rcn/158626_en.html)

<sup>[1]</sup> T.A. Atia, G. Elia, R. Hahn, P. Altamari, F. Pagnanelli - Journal of Energy Chemistry, (2019) 220-227.

<sup>[2]</sup> P.G. Schiavi, L. Farina, R. Zanoni, P. Altamari, I. Cojocariu, A. Rubino, M.A. Navarra, S. Panero, F. Pagnanelli - Electrochim. Acta, 319 (2019) 481-489.

# End of life photovoltaic panels

HTR researchers developed a process that allows the recycling of high-quality **solar glass** (which can be used for the production of new panels), the recovery of plastics and the recycling of valuable metals such as **Ag and Si** <sup>[3]</sup>.



[3] F. Pagnanelli, E. Moscardini, P. Altimari, F.C. Padoan, T.A. Atia, F. Beolchini, A. Amato, L. Toro - Journal of Environmental Management, 248 (2019) 109313.



## Financed Projects



Process and automated pilot plant for simultaneous and integral recycling of different kinds of photovoltaic Panels European Community: LIFE+ Environment Policy and Governance - 2014-2017 (Partner)  
<http://www.photolifeproject.eu/>



Optimization of a zero-waste treatment for recycling of end of life panels (2018-2019) Co-founded by the Italian Ministry of the Environment and Protection of the Territory and the Sea (Project coordinator)



## Patents

HTR researchers are inventors of several patents regarding the treatment of batteries, accumulators and photovoltaic panels.

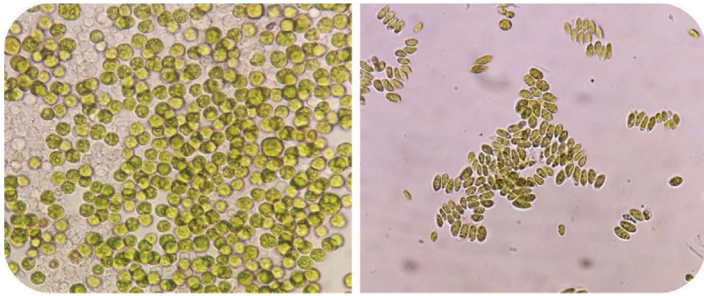
Plant and process for the treatment of exhausted accumulators and batteries (EP 2450991) European Patent (2012)

Process for treating spent photovoltaic panels (WO2014184816) Patent Cooperation Treaty (2014) (EP2997169) European Patent (2016)



# Microalgal cultivation

HTR researchers developed an innovative process of heterotrophic cultivation of microalgae by optimizing an uncoupled nutrient feeding sequence that avoids system sterilization. Through this patented process higher concentrations and productivity of microalgae are obtained compared to conventional phototrophic cultivation in photobioreactors or open ponds. HTR researchers developed a recovery process of starch granules and antioxidant carotenoids from microalgae, which can be used in the formulation of polymeric films, feeds and foods.<sup>[4]</sup>



[4] F. Di Caprio, P. Altamari, G. Iaquaniello, L. Toro, F. Pagnanelli - Biochemical engineering journal -145 (2019) 127-136.



## Financed Projects



**MEWLIFE**

MicroalgaE biomass from phototrophic-heterotrophic cultivation using olive oil Wastewaters (LIFE17 ENV/I-T/000180) European Community's Seventh Framework Program (LIFE+) - 2018-2021 (Partner)  
<http://www.mewlife.eu/>

## Progetto Algae Energetiche



Algae Energetiche (Energy Algae) Development, design and implementation of a pilot plant for the production of biofuels from microalgae. Co-founded by the Italian Ministry of the Environment and Protection of the Territory and the Sea (2011-2013) (Participant)  
<http://www.eco-one.it/alghe-energetiche/>



## Patents

HTR researchers are the inventors of a microalgal cultivation system for starch production  
Process for the cultivation of microalgae for the production of starch (18211136.9) European Patent (2018)

