Funded by the European Union

FunctiGlass

Project title DC5: Selective recovery and reuse of rare earths from silica fibers and e-waste

Recruiting institution: University of Milano-Bicocca

Background
Over the past four decades, **glass, glass-ceramics and composites** have contributed to the most advanced socio-economic breakthroughs as high-tech materials. To compete with emerging economies such as China and India, the European glass sector must strive for product leadership by investing more in research and innovation to develop new materials and train specialists for a competitive but promising market.

Contributing to this challenge is the main objective of the 'Structured functional glasses for lasing, sensing and health applications' (FunctiGlass) project, dedicated to **advanced high-tech materials for three sectors: light sources, sensors and biological applications.**

FunctiGlass, coordinated by CNRS, is a unique interdisciplinary research and training programme with a **double degree** as part of Horizon Europe's Doctoral Networks (Marie-Skłodowska Curie Actions, project 101169415). It will train 11 doctoral candidates who will take part in a joint research training programme based on **very close cooperation between academia and industry.** It will ensure that the trainees are exposed to 11 academic environments (universities and research institutes) and 9 non-academic environments (industry and SMEs) representing 9 different countries. **Each PhD candidate will be supervised by two academic tutors from different countries (spending her/his time between both units) and one mentor (industrial partner)** to ensure cross-sector knowledge sharing and the acquisition of transferable skills with a focus on

entrepreneurship and innovation. Through the multi-dimensional training of the FunctiGlass programme, the 11 PhD candidates will excel in the future economy by acquiring a multi-dimensional perspective and mindset to become **future leaders in glass science and in particular glass-based nano/micro-structured materials.** Through this programme, they will find their own path of innovation in academia or industry.

The project will create the conditions necessary for the establishment of long-term relationships between the academic and private sectors for the transfer of technologies and skills.

5 institutions will award the double degrees: Université Côte d'Azur (Nice, France), Tampere Universities (Finland), Gottfried Wilhelm Leibniz University Hannover (Germany), University Milano-Bicocca (Italy) and the Institute of Low Temperature and Structure Research, Polish Academy of Sciences (Wroclaw, Poland).

Industrial partners: AOI Tech (France), Corning (France), Fastlite (France), Klearia (France), Else Nuclear (Italy), Nobula3D (Sweden), Nyfors Teknologi (Sweden), Rosendahl Nextrom (Finland), Scout Scientific Outsourcing (Poland).

Other universities involved in the project as partners (not awarding doctoral degrees): University of Cergy-Pontoise (France), University of Gent (Belgium), University of Pardubice (Czech Republic), University of Nazarbayev (Kazakhstan), Umeå University (Sweden).

Description of the PhD project

The development of efficient technologies for recovering strategic materials such as rare earths elements (RE) from end-of-life devices represents a crucial step in supporting the EU vision of urban mining and circular economy. This is particularly important due to the limited natural availability of REs, the high costs of extraction, and the increasing export restrictions.
To this end, the main objective of this project is to design a novel separation procedure for REs, focusing on the recovery of REs from e-waste, using an innovative solid-state extraction method. The final goal is to promote efficient waste management and facilitate the reintegration of secondary raw materials into the economic cycle. To achieve this, the project is divided into two main sections built on the collaboration of two partners.

At UNIMIB, the hiring institution, the research will focus on the preparation of advanced materials as solid phases for RE extraction and separation, utilizing wet-chemistry methods. The work will concentrate on the synthesis and characterization of hierarchically porous oxides, such as macro- or meso-porous SiO_2, TiO_2, and TiO_2 grafted SiO_2 nanoparticles [1-2]. To enhance the porosity of these materials, the use of templates and suitable structure-directing agents will be explored. Alternatively, natural aluminosilicates or aluminosilicates obtained from waste recovery process (geopolymers) will be investigated as potential environmentally friendly candidates [3]. In addition, the selective uptake of REs by these materials will be fostered through surface functionalization processes with suitable chelating molecules. Different nature and amounts of surface functional groups onto the oxide matrices will be tested (i.e. carboxylic, amine, carbamate, sulfur-based). The materials will be fully characterized from a morphological and structural point of view, as well as

their surface features investigated to assess their potential properties towards the RE extraction.

At UCA, the work will aim at evaluating the selectivity and the reversibility of the different solid materials developed at UNIMIB for the uptake of REs. A peculiar attention will be paid on the reactivity of the different functional groups anchored onto the oxide matrices. For that, in addition to classical characterization methods, potentiometric titration of the surface will be carried out in order to elucidate the acid/base reactivity of the surface and the total concentration of reactive surface sites. On the other hand, adsorption/desorption experiments will be carried out on the functionalized materials in the presence of individual RE and mixture of REs in order to evaluate the efficiency of the uptake/release in various physico-chemical conditions (i.e. pH conditions, ionic strength, presence of competing ions etc.). Based on these results, the optimal adsorption conditions could be determined, as well as the optimal conditions for the selective release of individual RE from the solid surface.
In the last part, tests of the optical properties of the recovered REs will be carried out and the reusability of REs explored by preparing new nanophosphors and active photonic structures.

1. Y. Hu et al., Size-Selective Separation of Rare Earth Elements Using Functionalized Mesoporous Silica Materials, ACS Appl. Mater. Interfaces 11 (2019) 23681.
2. R. Jebali et al., From adsorption of rare earth elements on TiO2 nanotubes to preconcentration column application, Microchemical Journal 149 (2019) 104021.
3. C. Cristiani et al., Rare Earths (La, Y, and Nd) Adsorption Behaviour towards Mineral Clays and Organoclays: Monoionic and Trionic Solutions, Minerals 11 (2021) 30.

Practical information

- Contract will start in October 2025, for 3 years.
- Recruiting institution: University of Milano-Bicocca (Italy)
- Doctoral school: Milano-Bicocca Doctoral School
- Industrial mentor: ELSE NUCLEAR SRL
- Host laboratory: Department of Materials Science, University of Milano-Bicocca (Italy)
- Supervisor: Prof. Roberto Scotti
- Co-host laboratory: Institut de Physique de Nice (France)
- Co-supervisor: Ass. Prof. Charlotte Hurel
- Secondments: Institute of Low Temperature and Structure Research, Polish Academy of Sciences (PAS)(3 months) ; ELSE NUCLEAR SRL (EN)(1 month)
- The gross monthly salary based on the MSCA rules varies between 1920€ and 4063€, depending on the country of recruitment.
- The student will also receive a mobility allowance and a family allowance (depending on family situation) of up to 600 € and 495€ per month, respectively.

Recruitment criteria

- MSCA Mobility Rule: researchers must not have resided or carried out their main activity
- (work, studies, etc.) in the country of the recruiting beneficiary for more than 12 months in the
- 36 months immediately before their date of recruitment
- All researchers recruited in a DN must be doctoral candidates (i.e. not already in possession
- of a doctoral degree at the date of the recruitment)

- Possession of a Master’s degree before the start date of the contract
- Scientific excellence to fit the PhD project
- Fluent (oral and written) English skills as the project operates in English language
- Team-mindedness

Criteria specific for PhD5

- Good knowledge in work in chemical laboratory and general chemistry
- Basic knowledge in surface characterization, synthesis of inorganic materials, material sciences, physico-chemistry of inorganic interfaces
- Master degree in physico-chemistry; chemistry; materials science.

Application
Documentation to be sent in by the applicants

- Application form completed
- CV + Letter of motivation
- Contact of two reference persons to be contacted by the selection committee (name, relation to the candidate, e-mail address and phone number)
- Complete list of publications and academic works
- Proof of language proficiencies
- Proof of master diploma or 2024 registration to master degree

How to apply?

- Download application form and fill it indicating all the offers you wish to apply for
- Send your application by email to **recruit@functiglass.eu**. The title of your email MUST be:
  FunctiGlass PhD x, x, x application (x, x, x being the number(s) of the PhD position(s)you want to apply for)
- Be careful to join all documentation required (see list above)

Deadline for application
15th April 2025

Contact
contact@functiglass.eu