



PhD in INGEGNERIA DEI MATERIALI / MATERIALS ENGINEERING - 39th cycle

**PNRR 117 Research Field: ASSESSING VIABILITY AND STABILITY OF ENHANCED CO₂
STORAGE IN SEAWATER**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

**Motivation and objectives of the research
in this field**

The 2015 Paris agreement laid the groundwork for limiting the global temperature rise to 1.5 °C, but anthropogenic global warming is now likely to overcome this limit between 2030 and 2050. Most the global warming is caused by greenhouse gases, the most prominent one being CO₂. This has a long lifetime so that, even if CO₂ emissions stopped tomorrow, it would take centuries for the molecules in the atmosphere to be naturally reduced below a safe limit. For this reason, it is necessary that, together with global decarbonization, techniques be developed to remove CO₂ from the atmosphere (negative emissions). Among the various strategies to remove and permanently store CO₂, recent developments go in the direction of using seawater, which is already a natural sink for CO₂, converting it into carbonates and bicarbonates (prevalent forms in neutral/mildly basic water solution). This project, in cooperation with the newborn company LIMENET (<https://limenet.tech>) aims to test and improve some of the existing technologies in order to speed up the natural uptake of CO₂ by the oceans, make it more reliable over time, drastically reduce the costs of the process and ensure that it is environmentally friendly. The study will include experimental measurements with analytical instruments, both in the laboratory and in the environment, statistical elaboration and description of the data, and development of theoretical models to improve the reliability and efficiency of the process.



Methods and techniques that will be developed and used to carry out the research	The analytical techniques adopted in this research consist in: determination of the carbon content in seawater solution measuring the Total Inorganic Carbon (TIC); measuring alkalinity of the solution; measuring pH and conductivity of the solutions; measuring and interpreting X-ray diffraction spectra on solid phases. The statistical analysis will involve inference statistics and multivariate analysis. The theoretical modelling implies thermodynamic and kinetic analyses of the chemical reactions involving CO ₂ in equilibrium, quasi-equilibrium, and non-equilibrium conditions.
Educational objectives	The PhD candidate will learn techniques for the experimental characterization of inorganic carbon content in solution and in solids, and for the determination of solid state phases. He/she will learn numerical modelling and statistical analysis methods, and will also acquire scientific writing and presentation skills.
Job opportunities	The field of CO ₂ sequestration and storage is rapidly evolving and we envisage excellent job opportunities for the PhD graduate both in the industrial and academic sector, with unprecedented career opportunities.
Composition of the research group	3 Full Professors 3 Associated Professors 0 Assistant Professors 3 PhD Students
Name of the research directors	Prof. Guido Raos / Prof. Piero Macchi

Contacts	
<p><i>guido.raos@polimi.it;</i> <i>piero.macchi@polimi.it</i></p> <p><i>https://3most.chem.polimi.it/</i></p>	

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--



Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Limenet Via Filanda Maggiore 5, 23851 Galbiate (LC) https://limenet.tech/
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	University of Hamburg Prof. Jens Hartman, Universität Hamburg Bundesstraße 55 20146 Hamburg https://www.geo.uni-hamburg.de/
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>Confidentiality: since this is a thematic scholarship, the management of Confidential Information, Results and their publication is subordinate to the restrictions agreed upon with the funding company. Upon acceptance of the scholarship, the beneficiary must sign a specific commitment.</p> <p>Individual budget for research (5.700 euro): 1st year: 1.900 euro; 2nd year: 1.900 euro; 3rd year: 1.900 euro</p> <p>Teaching assistantship (availability of funding in recognition of supporting teaching activities by the PhD student): there are various forms of financial for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities within the limits allowed by the regulation.</p>