



# PhD in CHIMICA INDUSTRIALE E INGEGNERIA CHIMICA / INDUSTRIAL CHEMISTRY AND CHEMICAL ENGINEERING - 38th cycle

**PNRR\_352 Research Field: SYNTHETIC ROUTES FOR PREPARING PYRROLE  
DERIVATIVES: CHEMICAL AND INDUSTRIAL ASPECTS**

**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 PhD activity is focused on the synthesis of novel chemical substances, in particular of organic substances, more in particular of heterocyclic organic substances. These chemical substances will be preferentially prepared from biosourced chemicals and from wastes and residues, with the objective of preparing circular material in the frame of a circular economy. The syntheses will be performed in line with the principles of green chemistry. Research will be performed in order to optimize the synthetic procedure, to improve the yield and the atom efficiency and to minimize the E factor of the process, defining a procedure suitable for the scale up to pre-industrial scale. Neat syntheses, without the use of solvents, will be developed. This type of syntheses and processes for these novel chemical substances are not available in the state of the art. One objective of the research will be to collect the calorimetric data of the reactions, such as reaction enthalpy, adiabatic temperature rise, and activation energy. The novel chemical substances will be used as ingredients of elastomer nanocomposites for the so called green tyre compounds, for low dissipation of energy. Objective is the substantial reduction of the carbon footprint of tyres.

**Methods and techniques that will be developed and used to carry out the research**

The typical techniques of synthetic organic chemistry will be explored. In particular, the facilities for the preparation



	<p>of small organic molecules will be used both through wet and solid state synthesis. Processes under vacuum or in inert conditions will be considered. The use of distillation systems and chromatographic purification processes will be carried out. Calorimetric techniques will be used. Mass spectrometry techniques and NMR and infrared spectroscopies will be used for the evaluation of the degree of purity of the synthesized molecules in concert with the confirmation of the chemical structure. The novel chemical substances will be used as ingredients of elastomeric nanocomposites, prepared by using the typical instruments such as internal mixer and characterized by means of rheological, dynamic-mechanical and tensile tests. Materiali Sensibili and Reagens will be involved in the synthesis and scale up of the novel chemical substances and Pirelli will be involved in the preparation and characterization of elastomer nanocomposites</p>
<b>Educational objectives</b>	<p>Main objective is to give to the student high education, to be able to: (i) perform chemical reactions inspired by the principle of green chemistry (ii) monitor the chemical reactions in view of their scale-up (iii) prepare low molar mass chemicals (iv) perform reactions on organic substrates (v) characterize organic molecules (vi) perform the scale up of a chemical process (vii) prepare and characterize elastomer nanocomposites. Thanks to the higher learning, the candidate will acquire the ability to play a leading role.</p>
<b>Job opportunities</b>	<p>The Research Doctor will be able to find a natural location both in private and public companies and institutes active in the field of chemical synthesis, in particular in R&amp;D Department.</p>
<b>Composition of the research group</b>	<p>1 Full Professors 3 Associated Professors 3 Assistant Professors 7 PhD Students</p>
<b>Name of the research directors</b>	<p>Prof. M.S. Galimberti, Prof. ssa V. Barbera</p>

#### Contacts

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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)	Pirelli Tyre, Materiali Sensibili, Reagens
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	Il progetto promuove collaborazione con enti internazionali di rilievo
By number of months abroad	6

**Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information**

**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.

**Individual budget for research** (during the 3 years): about 5.400 euro

**Teaching assistantship:** availability of funding in recognition of supporting teaching activities by the PhD student. There are various forms of financial of 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.