



PhD in CHIMICA INDUSTRIALE E INGEGNERIA CHIMICA / INDUSTRIAL CHEMISTRY AND CHEMICAL ENGINEERING - 40th cycle

PNRR 630 Research Field: INNOVATIVE CIRCULAR MATERIALS FOR TYRE COMPOUNDS

Monthly net income of PhDscholarship (max 36 months)

€ 1500.0

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 United Nations have highlighted the role of transport in sustainable development:
<https://www.epa.gov/sustainability>. People and freight must be transported, and tyres are needed to do that. The greatest impact of tyres on the environment is during their use and is due to two main factors: rolling resistance (RR), i.e., the energy dissipated per unit traveled distance, and tyre debris. Tyre compounds are essentially based on hydrocarbon elastomers and traditional fillers such as carbon black and silica. These materials can be tuned to reduce rolling resistance. However, a remarkable improvement is required. Moreover, these materials are definitely not biodegradable. A quantum leap in innovation is thus required. New generations of materials must be designed and developed. They should be prepared from biosources and/or wastes and should be biodegradable, with more favorable kinetics with respect to the traditional materials. The innovation should have as a basic feature sustainability. This is clearly reported by Pirelli, the company that gives financial support to this research:
<https://corporate.pirelli.com/corporate/en-ww/sustainability/sustainability>.
 The main objective of the research is to design, prepare, and characterize innovative materials from biosources and waste. The main objective will be the replacement of the traditional elastomer matrix. Hence, polymers will be prepared, preferentially step growth polymers. End-of-life



	<p>polymers will be used to prepare the new materials. Biosourced fillers will be used, and their interaction with the matrix will be promoted by using innovative chemicals from waste and biosources. The research aims at preparing innovative elastomer nanocomposites suitable as tyre compounds that can meet the demanding requirements of a tyre compound, reduce the energy dissipation of a tyre during its use, reduce the impact on the environment of the tyre debris, and promote circularity.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>The research will be carried out using experimental techniques and facilities suitable for the preparation and characterization of (i) low-molecular-mass chemicals, (ii) polymers, and (iii) elastomeric nanocomposites. All the techniques for the preparation of the materials will be in line with the basic principles of green and sustainable chemistry and materials. Wet and solid-state syntheses will be carried out. Elastomer nanocomposites will be preferentially prepared by means of melt and latex blending. A thorough literature survey will be an essential part of the work. For low-molecular-mass chemicals, analytical techniques such as chromatography, NMR spectroscopy, calorimetry, thermogravimetric, infrared, and Raman analysis will be used. For the elastomeric composites, curing kinetics, tensile, and dynamic-mechanical properties will be determined. The thesis will be developed with funding by Pirelli Tire. Pirelli will be involved in the preparation and characterization of elastomer nanocomposites.</p>
<p>Educational objectives</p>	<p>The activity is aimed at giving high education, allowing the student to be able to:</p> <ul style="list-style-type: none"> i) perform chemical reactions inspired by the principles of green and sustainable chemistry; ii) prepare and characterize low and high molar mass chemicals; and (iii) prepare and characterize elastomer nanocomposites. <p>The student will be able to understand and apply the guidelines for sustainability.</p>
<p>Job opportunities</p>	<p>The research doctor will be able to find a location, in</p>



	particular in the R&D Department, both in private and public companies and institutes active in the fields of chemical synthesis, preparation of polymer composites, and elastomer nanocomposites, in particular for tyre applications and high-performance applications.
Composition of the research group	1 Full Professors 3 Associated Professors 2 Assistant Professors 9 PhD Students
Name of the research directors	Prof. M.S. Galimberti. Dr.ssa V. Barbera

Contacts	
maurizio.galimberti@polimi.it; vincenzina.barbera@polimi.it	

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	750.0 €
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 S.p.A Viale Piero e Alberto Pirelli 25, 20126 Milano https://www.pirelli.com/
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	Deutsches Institut für Kautschuktechnologie e. V. Eupener Straße 33, 30519 Hannover, Deutschland https://www.dikautschuk.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.</p> <p>Upon acceptance of the scholarship, the beneficiary must sign a specific commitment.</p> <p>Individual budget for research (about 6.000 euro): 1st year: 2.000 euro; 2nd year: 2.000 euro;</p>



3rd year: 2.000 euro

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.