



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

**PNRR 630 Research Field: RESEARCH ON COMPATIBILIZING AND CROSS-LINKING
ADDITIVES CAPABLE OF SURPASSING THE PHENOL-FORMALDEHYDE SYSTEM**

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 tyre industry is one of the most impacting chemical industries in terms of production volume, raw materials and energy consumption. The sustainability goals set by the 2030 UN Agenda for Sustainable Development clearly motivates improvements in responsible production through industry innovation. For this reason, tackling the challenges of the tyre industry represents nowadays a fundamental target for basic and applied chemical research. Pirelli Tyre S.P.A and Politecnico are strongly committed to improve the sustainability of the tyre industry. Recent advancements from Pirelli led to the commercialization of a new tyre generation with up to 55% bio-based and recycled material (P-ZEROTM-E). This achievement represents a solid ground for further collaborative research towards more sustainable tyres. In this context, the chemistry of compatibilizing and cross-linking additives for rubber-fiber composites represent an opportunity for innovation, as at present it is based on the phenol-formaldehyde system, which poses several concerns in terms of safety and sustainability. Within the doctoral studies proposed here we aim at finding a compatibilizing and cross-linking system capable of surpassing the phenol-formaldehyde system in terms of safety and sustainability, following the principles of green chemistry. Indeed, the phenol-formaldehyde system is a fully oil-based product, and its toxicity and volatility raise



	<p>health concerns. Given these premises, the requisites of the new additives are the following:</p> <ol style="list-style-type: none"> 1) they must be biobased materials derived from renewable biomasses; 2) their functionalization needs to be as green as possible, employing sustainable chemical methods and low-energy consumption; 3) their production needs to be scalable to the industrial needs; 4) the system must equal or outcompete the phenol-formaldehyde resin in terms of binding properties and cost; 5) the new system must outcompete the phenol-formaldehyde resin in terms of safety and sustainability.
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>Prior art and literature search will define the boundaries of chemical space for the investigation. Acquisition of building blocks, extraction from biomasses and their derivation through synthetic chemistry will be guided by the principle of green chemistry. Mild chemical methods will be employed, preferably employing recyclable solvents, reagents and catalysts, ideally employing enzymatic catalytic methods in water or biobased solvents. The competence of the group at Politecnico in biomass valorization through fractionation and derivatization will be merged with the knowledge of collaborators at Pirelli Tyre S.P.A in the design, synthesis and testing of compatibilizing and cross-linking additives. Several analytical methods will be employed for the characterization of the additives at molecular level (NMR, MS, IR, UV) offered by the analytical platform at Politecnico. Further testing will be performed at Pirelli Tyre S.P.A to investigate the performance of the additives in rubber composites, and as adhesives in rubber-fiber composites, through state-of-the-art material analysis and mechanical testing. Once the best performing additives will be identified and their synthesis optimized in the laboratory at Politecnico, the kilo-lab at Pirelli will enable scalable production of the additives for larger-scale testing. Overall, the PhD candidate will have the opportunity to train in synthetic chemistry and small molecule analysis at Politecnico and deepen the analysis</p>



	and testing of the material in the field of rubber composites in the R&D laboratories of Pirelli.
Educational objectives	The educational objective is to train the candidate in research, from prior art search and literature survey, to experiment planning, experiment execution, data analysis and interpretation, scientific writing and presentation. All in the context of a research group and team-work spirit.
Job opportunities	The research and educational training provided by the PhD in Industrial Chemistry and Chemical Engineering will provide solid foundations for a research-oriented job in the chemical industry. The close collaboration with Pirelli Tyre S.P.A. will strongly rise the industrial profile and experience of the candidate.
Composition of the research group	1 Full Professors 3 Associated Professors 3 Assistant Professors 4 PhD Students
Name of the research directors	Dr. D. Fiorito, Prof.ssa P. D'Arrigo

Contacts

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<https://www.cmic.polimi.it/ricerca/elenco-gruppi-di-ricerca/biocatlab/>

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/tyres/it-it/auto/home
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	To be defined
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 (about 6.000 euro):

1st year: 2.000 euro;

2nd year: 2.000 euro;

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.