POLITECNICO DI MILANO

PhD in CHIMICA INDUSTRIALE E INGEGNERIA CHIMICA / INDUSTRIAL CHEMISTRY AND CHEMICAL ENGINEERING - 39th cycle

THEMATIC Research Field: SUSTAINABLE MATERIALS FOR 3D PRINTING.

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	In recent years, interest in 3D printing has gained momentum not only in academia, but also in industry. Between 2014 and 2015, numerous 3D printing companies entered the market and new start-ups, spin-offs and subsidiaries continue to emerge. According to the latest market research from Mordor Intelligence, the global printing industry was valued at $586.13 million in 2019 and is projected to reach $1949.94 million by 2025, which is equivalent to a rate of compound annual growth (CAGR) of 21.91% for the period 2020?2025. These values were confirmed by another report, in which the value of the 3D printing market is projected to reach $1,647.4 million by 2024 with a CAGR of 20.4% for 2019-2024. The growth of the 3D printing industry, mainly driven by technological improvements on materials and 3D printers, has prompted economic operators to develop and improve their existing production and distribution capabilities, in order to market technologies and services. Over the next few years, this will involve the hiring of specialized professionals oriented towards research and development, of which the PhD trained in this context would represent the maximum expression. Alongside the distribution of 3D printing goods or services, its use in the creation of high-precision products is becoming increasingly popular in the industrial sector. Traditional production processes are gradually being replaced by new ones based on additive manufacturing.

	The main objectives of the PhD work are: •Analysis of existing processes and usable materials •Preparation of composites from recovered products on a laboratory scale •Study of extrusion of the composite material produced and 3D printing •Scale-up and applications in different fields.
Methods and techniques that will be developed and used to carry out the research	The student will combine the enormous technological efforts made on additive manufacturing techniques in recent decades with the recovery of processing waste, in order to guarantee products with high added value and reuse of raw materials, fully entering the context of a circular economy. The materials produced must then be degradable, in order to ensure sustainable management at the end of their life and should be used by Wolz Nautic Italy. To allow polymer degradation with controlled kinetics, special crosslinkers will be developed which can be split by light or by changing the pH value. The thermomechanical properties of the final polymer or composite will then be optimized on the basis of the investigated applications, by intervening on the chemical composition and on the printing process. To this end, the student will take advantage of the availability of cutting-edge 3D printers, from the more classic extrusion printers to the more precise ones based on stereolithography and two photons. Activities and responsibilities: •Development of washable crosslinkers •Development of printable polymeric resins from renewable sources •Valorisation of waste products in the printable material formulation •Optimization of the printing process for the creation of materials with high added value.

Educational objectives	The student at the end of the PhD project will develop the following skills: polymer chemistry (hydrogel preparation and functionalization), materials design, controlled drug delivery systems (application in different medical fields), optical technologies and mathematical modeling.
Job opportunities	The PhD student at the end of this project can spend his or her skills in different industrials fields. In particular in the industrial sectors related to cosmetics, pharmaceutics and laser technologies.
Composition of the research group	0 Full Professors 1 Associated Professors 3 Assistant Professors 0 PhD Students
Name of the research directors	Prof. Filippo Rossi

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

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

Individual budget for research: funding for participation in courses, summer schools, workshops and conferences) - financial aid per PhD student per year:
1st year: about 1.900 euros - 2nd year: about 1.900 euros - 3rd year: about 1.900 euros

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.