POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 40th cycle

PNRR 630 Research Field: SMART BIG AREA ADDITIVE MANUFACTURING FOR THE CIRCULAR AND SUSTAINABLE TRANSITIONS

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 Industry 4.0 framework together with ongoing and future European strategic plans (Horizon, ManuFuture, NextGenerationEU), with their strong orientation towards EU research and innovation, call for accelerating the twin (i.e., green and digital) transition. In this framework, advanced and smart additive manufacturing processes represent key enabling technologies for a more sustainable product value chain, opening to innovative zero-defect solutions with minimum waste of materials and resources. The research activity carried out with this scholarship will specifically focus on the development of novel digital and smart methods to enable a zero-defect and first-time-right additive manufacturing capability for very large parts, as a building block towards an increased competitiveness in the framework of the circular and sustainable transitions. The aim is to anticipate the identification of the onset of defects while the part is being produced, and to adapt - in line and in situ - the process parameters to prevent the defect growth and propagation from one layer to another. The described research activities are coherent with three of the six major areas of intervention (pillars) on which the PNRRs will have to focus and in particular: •Green transition •Digital transformation •Smart, sustainable and inclusive growth The research activity is characterized by an

	interdisciplinary approach, covering aspects and topics ranging from advanced sensing and measurement techniques to big data analytics, additive manufacturing process characterization and optimization. The industrial application framework is strongly focused on strategic sectors for the European industrial competitiveness, involving the direct involvement of a leading player in the field of big area additive manufacturing of high-value-added parts, namely Camozzi Research Center. The research environment is intensely multicultural, as the candidate will have the chance to contribute to national and international research &innovation networks and consortia including the main academic and industrial players in the smart and sustainable manufacturing arena (see also the job opportunity section below). The period spent broad will allow the candidate to further strengthen her/his own international network, fostering a multidisciplinary attitude towards complex problem solving.
Methods and techniques that will be developed and used to carry out the research	The research has a strong focus on the study, development, characterization, comparison and validation of novel smart methods to enhance the quality and stability of big area additive manufacturing processes. Thus, rigorous experimental techniques, mechatronics methods, physical models, and advanced statistical and machine learning algorithms will be combined to design, implement, and validate the innovative solutions proposed. Team-working will be stimulated with the aim of providing appropriate solutions to actual challenges, which require multidisciplinary skills.
Educational objectives	Doctoral candidates will acquire competences on design, optimisation, and sensing/controlling of additive manufacturing processes and systems.
Job opportunities	Italy and Lombardy Region have leading positions in manufacturing worldwide. Our last survey on MeccPhD Doctorates highlighted a 100% employment rate within the first year and a 35% higher salary, compared Master of Science holders in the same field. Job opportunities will be evaluated within the Camozzi Group, but also in

	agencies and top level universities that are collaborating with the research group on the specific topics of this call. List of Universities, Companies, Agencies and/or Nationalor International Institutions that are cooperating in the research include: Camozzi Group, Ingersoll Machine Tools, MIT - Massachusetts Institute of Technology, TUM - Technical University of Munich, ESA - European Space Agency, Georgia Tech University.
Composition of the research group	1 Full Professors 2 Associated Professors 3 Assistant Professors 10 PhD Students
Name of the research directors	Prof. Bianca Maria Colosimo

Contacts
Phone: +39 02 2399 8530 For questions about scholarship/support please contact phd-dmec@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)	Camozzi Research Center S.r.l.
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	Ingersoll Machine Tools (USA)
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of euro 6.114,50. Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. There are various forms of financial aid 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 regulations.

POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 40th cycle

THEMATIC Research Field: DE-REMANUFACTURING SYSTEMS

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	Circular economy has become one of the key strategic priority of the European Union. In order to introduce circular economy in manufacturing one of the key problem is to regain or even upgrade the functions of the product after a round of use of the product has been completed. Therefore, De-remanufacturing plant need to be created in Europe entailing a deep change in the European manufacturing industry. There is the need to be able to design and manage de-remanufacturing facilities which are different from classical facilities since the quality of incoming cores is normally not completely known. As a result, very flexible and reconfigurable systems have to be designed and managed in presence of uncertain input in quality, quantity, time of availability.
Methods and techniques that will be developed and used to carry out the research	Methods to manage de-remanufacturing systems call for the ability to devise on the fly programs to run the whole system and the single devices. This has to be done on the basis of the results on the inspection of the incoming cores, therefore products can be considered one of a kind even if they have to be produced in high volumes. This calls for new models to program flexible devices in order to take advantage of flexibility. AI can also be investigated by using methodologies and tools that guarantee the safety of the operations. At design levels the need of flexibility and reconfigurability must be carefully planned while taking into account the stochasticity in terms on quality, quantity, time of availability using models based on stochastic programming and dynamic stochastic

	programming.
Educational objectives	The goals is to prepare a PhD able to deal with the complex problems connected with the planning of de-remanufacturing facilities who is knowledgeable of the techniques which can be adopted and is aware of the real problems related to particular classes of product with particular refence to electric vehicles. The ability to understand and cope with completely new disruptive scenarios of manufacturing which departs from the classical theory is a distinctive feature of the formed figure.
Job opportunities	Introducing de-remanufacturing in Europe calls for a complete modification of the European manufacturing base. Therefore, there is at industrial and academic level the urgent need of scientist able to understand the new situation, model it and introduce new methodologies and tool to address it. It can be envisaged that due the pervasiveness of circular economy there will be a dramatic lack of experts able to deal with the new situation both at industrial and academic level. List of Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research include: Karlsruhe Institute of Technology (KIT), University of Aachen (RWTH)
Composition of the research group	2 Full Professors 1 Associated Professors 1 Assistant Professors 5 PhD Students
Name of the research directors	Prof. Tullio Tolio

Contacts
For questions about scholarship/support please contact phd-dmec@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

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

Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of euro 6.114,50.
Our candidates are strongly encouraged to spend a research period abroad, joining high-level research groups in the specific PhD research topic, selected in agreement with the Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approx. 750 euro/month- net amount).
Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. There are various forms of financial aid 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 regulations.

POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 40th cycle

INTERDISCIPLINARY Research Field: SUSTAINABLE SOLID-STATE BATTERIES FROM DESIGN TO MANUFACTURE AND REUSE

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	Interdisciplinary PhD Grant The PhD research will be carried out in collaboration with research groups of the PhD programme in "**MATERIALS ENGINEERING**". See https://www.dottorato.polimi.it/?id=422&L=1 for further information. The current push towards electrification of mobility will generate an extensive transformation both in society and in the industry. The need for energy storage devices will abruptly increase as automobiles, trains, ships, drones, and other vehicles adopt the electric energy. Solid state battery (SSB) technologies will be essential to achieve the energy density and the power required by traction applications by also providing improved safety. The SSB technologies are of strategic importance for the democratic use of energy, appropriate use of the resources, and the fight against the climate change. For a production in the industrial scale the use of correct material chemistries, digital and flexible manufacturing, recycling, and recovery processes are required. This project aims to design the next generation SSBs exploiting advanced materials and manufacturing processes enabling with a traceable and benign environmental impact from conception to end of life.
Methods and techniques that will be developed and used to carry out the research	The research will involve two departments of the Politecnico di Milano namely the Department of

	Politecnico di Milano namely the Department of Mechanical Engineering (DMEC), and Department of Chemistry, Materials and Chemical Engineering "Giulio Natta" (DCMC). DMEC group will provide the digital manufacturing processes based on laser technology for a safe, digital, and sustainable production chain at SITEC - Lab for Laser Applications. The DCMC group will provide the expertise on the solid-state battery technology with advanced materials and functionalization expertise at SEE Lab. The interdisciplinary project will constitute an exceptional platform combining competences that span over electrochemistry, material science, and manufacturing processes required as the basis for the giga-factories of the future. The Li-metal based anodes, solid eletroclytes, and cathodes will be produced considering their ease of recovery and use. The laser-based surface functionalization, separation, and welding processes, as well ablation based selective material recovery processes will be investigated. The project aims to demonstrate the production of prototype battery systems i-house made based on synthesized, recovered, and recycled materials and electrically characterized providing benchmark data highly required by the industry. The project will carry out LCA for all the envisaged cases indicating the most suitable recovery and recycling solutions.
Educational objectives	The provided tools will bridge the knowledge between chemistry, materials science, production engineering making use of environmental assessment tools to provide solutions to produce in large scale SSBs in Italy and Europe. Only with the aid of these tools, the resources can be used in an efficient manner during manufacturing, usage, and end-of-life phases. - Design and develop manufacturing and reuse processes - Develop and synthesize new materials - Benchmark electrochemical behaviour of pristine and reused battery systems - Carry out LCA
Job opportunities	Italy and Lombardy Region have leading positions in construction and manufacturing worldwide. PhD students

	are employed within the first year in national and international companies and academic and non-academic research institutions, engaged in innovation, research and technical development. List of Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research: TU Munich, Solvay Specialty Polymers Italy
Composition of the research group	2 Full Professors 1 Associated Professors 3 Assistant Professors 10 PhD Students
Name of the research directors	Prof. Ali Gökhan Demir, Prof. Luca Magagnin

Contacts
Phone +390223998590 *Email* aligokhan.demir@polimi.it https://www.mecc.polimi.it *Phone* +390223993124 *Email* luca.magagnin@polimi.it www.cmic.polimi.it For questions about scholarship/support please contact phd-dmec@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

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of euro 6.114,50. Our candidates are strongly encouraged to spend a research period abroad, joining high-level research groups in the specific PhD research topic, selected in agreement with the Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approx. 750 euro/month- net amount). Teaching assistantship: availability of funding in recognition of supporting teaching activitiesby the PhD candidate. There are various forms of financial aid 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 regulations.