Finanziato dall'Unione europea
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UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA

MUR

Scienza e Nanotecnologia dei Materiali curr. Tecnologia dei Materiali	
Progetto di ricerca/ Research project	*"Nanocompositi sostenibili e con proprietà "self-sensing" per il monitoraggio dell'integrità strutturale" (codice progetto MAT.1)* *"Self-sensing sustainable composites for damage monitoring"* (project code MAT.1)
Type	DM 352 of 9 April 2022
Docente proponente/ Proposing Professor	Prof. Marco Bernasconi
Abstract	**ITA** Due to their outstanding performances, fibre reinforced polymers (FRPs) are widely used as structural parts in several fields, including automotive, aerospace, and wind turbines. Usually made up of carbon or glass fibres (CF, GF) immersed in a thermoset matrix, they are optimized for severe working conditions which lead to a progressive decrease in stiffness during their in-service life up to the final failure. This implies a reduction of the products life, increasing waste problems, with negative environmental and economic fallouts. Structural Health Monitoring (HM) is a powerful tool for promoting a more cost-effective and sustainable planning, control and management of FRP structures. If on one side the identification of the damage within the composite is essential, on the other side the ambition to integrate circular criteria in the FRPs design and the development of suitable predictive models for continuous monitoring, real time and online assessment, appear crucial for decreasing the materials usage and the overall environmental footprint. Within this scenario, the present project aims at developing, implementing, and validating an innovative and sustainable solution for the HM of FRPs, allowing for the continuous assessment of their damage state, while improving their environmental impact. HM will be performed by exploiting the intrinsic self-sensing capabilities of electrically conductive polymer composites, obtained by nanomodification of epoxy matrices with novel GF-based hybrid fillers, produced by nanocoating virgin GF with electrically conductive materials, acting both as effective reinforcing fillers and artificial neuron for the damage sensing. As a further innovative point, GF recovered from reinforced epoxy polymer wastes will be exploited as unconventional and sustainable alternative for FRPs design. After an optimization of the manufacturing parameters, the activity will be directed to characterise the Electrical Resistance Change (ERC) caused by damage events,

investigating and comparing the effectiveness of the different fillers on the self-sensing capability of FRPs. Experimental observations will inspire suitable predictive models which will be developed in tight collaboration with CRPI S.r.l., with the goal to link the ERC with the materials life.

Eventually, a demonstrator (i.e. mini wind generator) representative of actual structural component to be applied in the renewable energy sector will be produced, to finally assess the self-sensing capability of the produced composites and to validate the reliability of the models developed for the estimation of the damage state. The outcomes of the project will have significant economic and societal impacts not only in terms of extending the lifetime of structural parts, thus preventing the cost of unnecessary and unscheduled maintenance, but also for the identification of new circular economy value-chains based on the reuse of end-of-life FRPs.

ENG

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Azienda/Company	CRPI Compagnie Riunite Partecipazioni Industriali Srl, Viale Abruzzi, 72 – 20131 Milano
Mesi di ricerca in impresa/ Months of research in the Company	6 mesi / months
Mesi di ricerca all'estero/ Months of research abroad	min 6 – max 12 mesi / months
Intellectual property clauses agreed with the Company apply to this scholarship	

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Scienza e Nanotecnologia dei Materiali curr. Tecnologia dei Materiali	
Progetto di ricerca/ Research project	*"Derivatizzazione di polisaccaridi, loro caratterizzazione e impiego come medical device" (codice progetto MAT.2)* *"Polysaccharides derivatives: characterization and implementation as medical devices"* (project code MAT.2)
Type	DM 352 of 9 April 2022
Docente proponente/ Proposing Professor	Prof. Marco Bernasconi
Abstract	**ENG** The PhD work will have two main objectives: the first objective is to investigate the physical-chemical characterization of polysaccharide and their derivatives; the second objective is to deepen our understanding of the interaction between biological active molecules and different polysaccharide-based polyelectrolytes. Polysaccharides are heterogeneous and polydisperse compounds, and a study of their properties, such as molecular distribution, viscosity, size, and surface charge, is of essential to determine and predict their biological functions or applications. The setup of chemical-physical methods suitable for evaluating the polymers and the complex with biological molecules, such as NMR, Photon Correlation Spectroscopy (PCS), Zeta Potential evaluation techniques or Isothermal Titration Calorimetry, will be used not only for modulating the new formulations, but also for evaluating different interactions within the solution. Polysaccharide derivatization, modification, and characterization will be primarily be conducted at the SEFI Lab, the Surface Engineering and Fluid Interfaces Laboratory led by Prof. Carlo Antonini at the Department of Materials Science. IFBS will host the PhD student to conduct the complementary characterizations, which are not available at UNIMIB, and to define the industrial challenges for the implementation of polysaccharide derivatives as medical devices.
Azienda/Company	IFBS - Istituto Farmaco Biologico Sperimentale, Via G. Carducci, 64/D San Giuliano Terme (Pisa)
Mesi di ricerca in impresa/ Months of research in the Company	6 mesi / months

Mesi di ricerca all'estero/ Months of research abroad	min 6 – max 12 mesi / months
Intellectual property clauses agreed with the Company apply to this scholarship	