POLITECNICO DI MILANO

PhD in INGEGNERIA DEI MATERIALI / MATERIALS ENGINEERING - 40th cycle

INTERDISCIPLINARY Research Field: POLYMERS FOR HYDROGEN APPLICATIONS

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	Interdisciplinary PhD Grant The PhD research will be carried out in collaboration with research groups of the PhD programme in "**ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY**". See https://www.dottorato.polimi.it/?id=422&L=1 for further information. Currently, there is significant interest in using hydrogen as an energy vector to address global warming by reducing carbon dioxide emissions. However, the transport and storage of H2 could pose compatibility challenges for materials in storage and distribution infrastructures. In particular, the literature data indicate that polymers have higher permeability to H2 compared to methane, which could potentially lead to increased gas leakage, raising safety and economic issues. The absorption of H2 may also induce changes in the structure of the material, potentially impacting structural integrity, mechanical properties and durability. Nonetheless, experimental facilities to assess the suitability of materials for use in hydrogen environment are poorly available in both the academic and industrial sectors worldwide. The ultimate objective is to develop a broad knowledgebase of polymeric materials compatibility with hydrogen using suitable testing methodologies for better understanding material/hydrogen interaction.
Methods and techniques that will be developed and used to carry out the research	This project will start with already-existing facilities at Politecnico di Milano, which are the Polymer Engineering

	Lab (PolyEngLab) at the Department of Chemistry, Materials and Chemical Engineering “Giulio Natta” and the Laboratory of Energy Conversion and Storage (LabX) at the Department of Energy, to design and implement novel equipment for this purpose. More specifically, a multi-chamber pressurized and environmentally controlled system will be constructed to perform accelerated aging tests at varying gas composition, pressure, temperature and exposure time. The funds for realizing this equipment have been already partly secured. This study is much needed since the response of polymeric materials is strongly influenced by their structure, namely polymer type, grade, additive and filler formulation, crystallinity degree, molecular mass, and molecule orientation. Since all of these variables are highly dependent on the type of the supplier and the specific operating conditions of the application, a comprehensive characterization campaign of the elements used in practice in each specific infrastructure is strongly needed. This will also offer the opportunity for future innovation in materials specifically formulated for hydrogen applications. Different activities will be carried out during the investigation: (i) testing methodologies for accelerated testing of materials in H2 atmospheres having different compositions will be preliminarily defined based on the know-how available at the Polymer Engineering Laboratory (PhD course in Materials Engineering); (ii) optimisation and upgrade of the existing workbench for low-pressure H2 exposure currently available at the Laboratory of Energy Conversion and Storage (PhD course in Energy and Nuclear Science and Technology) to operate at high (25 bar) and very-high pressure (350 bar); (iii) implementation of a hydrogen exposure system that allows for separate chambers in which the hydrogen exposure conditions can be changed independently, varying both temperature and pressure over a relatively wide range of values; (iv) assessment of the effects of H2 exposure ageing for preliminarily selected materials by quantifying changes in their physical-mechanical properties; (v) development of predictive models for the long-term behavior of the

	polymeric components in infrastructures; ultimately, (vi) validation of the models based on the experimental results obtained.
Educational objectives	At a time when scientific research is strongly focused on the energy transition, the implementation of an experimental centre for the study of the interaction with the environment of polymeric materials which are widely used in the hydrogen infrastructure and the evaluation of the effects of such interactions constitutes a multidisciplinary educational objective for the advancement of knowledge of the physical-mechanical performance of materials at different scales.
Job opportunities	PhD graduates in this research field can find great job opportunities in the industry (from material producers to builders and operators of the hydrogen infrastructure as well in the academy (research groups are investigating topics related to materials application in the hydrogen infrastructure).
Composition of the research group	1 Full Professors 2 Associated Professors 1 Assistant Professors 0 PhD Students
Name of the research directors	Prof. Claudia Marano / Prof. Gianluca Valenti

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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

Confidentiality: since this is a thematic scholarship, the management of Confidential Information, Results and their publication may be subordinated to the restrictions.
Upon acceptance of the scholarship, the beneficiary may have to sign a specific commitment.

Educational activities (funding for participation in courses, summer schools, workshops and conferences) - financial aid per PhD student per year:
1st year: around 1.900 euros per student 2nd year: around 1.900 euros per student 3rd year: around 1.900 euros per student

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.