POLITECNICO DI MILANO

PhD in INGEGNERIA DEI MATERIALI / MATERIALS ENGINEERING - 41st cycle

THEMATIC Research Field: DEVELOPMENT OF COST-EFFECTIVE SOLUTIONS WITH IMPROVED PERFORMANCE FOR THE MANUFACTURE OF POWER CABLES

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 aim of the research is to identify adhesive materials and production process parameters to improve the quality of conductor cables. The goal is to significantly limit performance variability and/or the occurrence of defects in the final cable assembly.The activity will be divided n three main research topics: 1. improvement of the adhesion between the EPDM compound and the red copper, avoiding the use of glues to make the product more sustainable 2. possible use of austenitic stainless steel AISI 304 instead of the current AISI 316, with identification of the conditions that make the replacement possible, also considering the economic impact 3. addition of alternative inorganic fillers to replace the lead oxide, currently in use in the EPDM rubber used as electrical insulation for DWP cables, in order to make the compound more sustainable For each of the three topics, the research will be divided into the following phases: •acquire of the characteristics of the materials currently in use and perform literature and market research of possible alternatives •analyze the production cycle and identify possible critical

	issues •select new products and conduct comparative laboratory tests
Methods and techniques that will be developed and used to carry out the research	The research is developed with industrial funding by PRYSMIAN. The activities will be carried out mainly at the Politecnico di Milano with some periods of stay - previously agreed with Prysmian - at company or external research centers. The initial phase will be dedicated to a literature survey to correlate the types of raw materials used to their main characteristics in terms of technology, performance and durability. Information on the formulations of the adhesives and the available application and analysis methods will also be acquired. For example, the possibility of using a non-tinned copper conductor will be examined and the advantages and disadvantages compared to the current solution will be evaluated. A basic chemical-physical and mechanical characterization will also be conducted in order to identify the characteristics of the products and their characteristics to be checked during product quality verification, initially using the following analysis techniques selected from the range of those available at the Politecnico: Scanning calorimetry tests (DSC), Peeling tests, Scratch tests, Thermal stability tests, … Similar considerations will also be developed to verify the possible substitution of austenitic stainless steel AISI 316 with AISI 304. Localized corrosion resistance tests will be performed based on a preliminary definition of the corrosive environment. During a second phase, the production cycle will be improved. Based on the formulations adopted and the characteristics of the products, a detailed examination of the production process that characterizes Prysmian production will be carried out. This part of the research aims to identify possible critical issues regarding the products and to associate them with phases or parameters of the production cycle, which will then be monitored through sample tests to check their stability and reproducibility. The protocol of the tests to be performed

	will be established and agreed upon at the same time. On the basis of the experimental techniques for measuring the physical-mechanical characteristics identified in the previous point, the main equipment necessary for setting up a technological laboratory serving production will be identified and selected. The final purpose is to define the adhesive materials and the parameters of the production process in order to improve the quality of the conductive cables.
Educational objectives	The PhD student will gain expertise in the theoretical and experimental aspects related to the three topics outlined above, involving two distinct classes of materials (polymers and metals) and various characterization methods (e.g. mechanical, electrochemical…). The student will become familiar with all the aspects related to compatibility and adhesion metal-to-polymer and corrosion resistance of metals. The student will participate in international conferences.
Job opportunities	The skills and knowledge developed during this PhD represent a valuable asset not only for the oil &gas sector, but for many other application fields in which mechanical or electrochemical properties of materials are involved. The aim is to train engineers with high theoretical and technological expertise in the field of durability of materials, both polymeric and metallic in nature. Therefore, the specific area of professional development includes companies and institutions, which deals with issues of material selection
Composition of the research group	3 Full Professors 7 Associated Professors 6 Assistant Professors 19 PhD Students
Name of the research directors	Prof. Andena/Prof. Bolzoni

Contacts
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Web-pages of the research group:
https://www.cmic.polimi.it/ricerca/elenco-gruppi-di-ricerca/polyenglab/
https://polilapp.chem.polimi.it/

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents	--

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

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.

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
2nd year: around 1.900 euros
3rd year: around 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.