POLITECNICO DI MILANO

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

THEMATIC Research Field: ANODIC OXIDATION TREATMENTS FOR LIGHT ALLOYS FUNCTIONALIZATION

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	PARTENARIATO /CENTRO NAZIONALE: MICS CUP D43C22003120001 Decreto di concessione: n. 1551 del 11/10/2022 SPOKE n. 4 Anodizing is crucial for the "Made in Italy" industry for several reasons, each contributing to the high standards of quality, aesthetics, and performance that characterize Italian products. Key points are enhanced durability and corrosion resistance, aesthetic appeal, improved surface properties, versatility and, last but not least, value addition, with the possibility to induce a surface functionalization aiming at various contexts. In this research program, the application of anodizing treatments will focus on the main fields of application of anodizing, like aluminum and magnesium light alloys for aeronautic and aerospace, and titanium anodizing to produce air and water pollution remediation devices.
Methods and techniques that will be developed and used to carry out the research	Lightweight metals are crucial in the Made in Italy sector, enhancing sustainability and performance. To improve durability, tune their aesthetics and provide added functionalities, surface treatments can be applied, such as anodizing ones, which are the objective of this PhD. In particular, plasma electrolytic oxidation (PEO) involves the production of a think oxide by a high-voltage oxidation

	production of a think oxide by a high-voltage oxidation performed in an aqueous bath under plasma regime, while lower voltage solutions can be sought to nanostructure the material surface. The final properties of the coatings depend on several operational parameters, both electrical and chemical. In this PhD, particular attention will be devoted to the investigation of the treatment time and the applied voltage, so as to reduce the energy employed in the process and therefore tune it towards a better industrial applicability. Then, single-step and multi-step treatments with different duration and applied voltages will be analyzed to determine the optimal combination of parameters. As for PEO, these parameters show contrasting effects, so it is of paramount importance to properly balance them to produce thick and compact coatings, avoiding conditions that may lead to larger and more intense discharges and consequent increase in defects generation, combined with increasing costs arising from a higher energy demand. With reference to these treatments, the influence of the current regime (DC, DC pulsed and AC) and the duty cycle on the compactness of the PEO coatings will also be analyzed. Finally, the possibility of reducing the porosity level of PEO coatings by introducing ceramic particles additives in the electrolytic solution or carrying out sealing post-treatments will be considered. As for surface nanostructuring, combinations of surface pretreatment, electrolyte, voltage and time will be evaluated to give rise to the best morphology. The produced coatings will be characterized in terms of corrosion and electrochemical behavior by performing potentiodynamic polarization and electrochemical impedance spectroscopy tests; accelerated exposure tests (such as salt spray test); and long-term corrosion experiments (such as immersion tests). Moreover, their functionalities in environmental applications such as pollution reduction and hydrogen production will also be evaluated. Morphological and structural evaluation will also be provided by using scanning electron microscopy (SEM) and X-ray diffraction (XRD).

Educational objectives	The PhD will offer a 3 years education on the behavior of metals in contact with corrosive aqueous electrolytes. The student will become familiar with all the aspects related to wet corrosion theory of metals, protective techniques, material selection and specifically surface treatments. The student will participate at international conferences and will have a period of activity in a foreign country
Job opportunities	The aim is to train engineers with high theoretical and technological expertise in the field of corrosion and protection of metal structures, with a focus on surface treatments. Therefore, the specific area of professional development includes companies and institutions, which deals with the protection of metals exposed to both natural and industrial environments.
Composition of the research group	2 Full Professors 3 Associated Professors 3 Assistant Professors 3 PhD Students
Name of the research directors	Prof.ssa MP. Pedeferri - Prof.ssa M.V. Diamanti

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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 (tot. about 5.700 euro): 1st year: 1.900 euro; 2nd year: 1.900 euro; 3rd year: 1.900 euro

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.