POLITECNICO DI MILANO

PhD in SCIENZE E TECNOLOGIE ENERGETICHE E NUCLEARI / ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY - 40th cycle

THEMATIC Research Field: EXPERIMENTAL AND MODELLING ANALYSES OF PERFORMANCE AND DEGRADATION IN ANION EXCHANGE MEMBRANE WATER ELECTROLYZERS

Monthly net income of PhDscholarship (max 36 months)
€ 1600.0 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	As discussed in Paris COP21, targets regarding the reduction of fossil fuel consumption have been set at European level to achieve carbon neutrality by 2050. In particular, hydrogen has been identified as a crucial component in the decarbonization of hard-to-abate sectors, such as heavy industry, steel manufacture and transportation. However, hydrogen production is still largely dependent on fossil fuels, thus requiring a shift towards low-emission and renewable hydrogen to achieve the climate targets. Green hydrogen is produced through water electrolysis, which converts renewable electrical energy into chemical energy (hydrogen), resulting in zero carbon emissions. Moreover, Green hydrogen can also play a significant role in stabilizing the power grid, which in recent years has faced issues due to the fluctuating and intermittent nature of renewable sources.Among the different technologies, Anion Exchange Membrane Water Electrolyzers (AEMWEs) are receiving increasing attention due to several advantages, such as the adoption of less expensive platinum group metal-free electrocatalysts like alkaline water electrolyzers and the capability to produce pressurized hydrogen at a high hydrogen production rate. However, the performance and durability of AEMWEs need to be significantly improved for technology widespread commercialization. The

	presented research project will be performed in the framework of DURALYS project (Durable, Scalable, and Recyclable Components and Cell Designs for Next Generation Alkaline Exchange Membrane Water Electrolysis, CUP C93C24006220001) with the aim to improve the understanding of the physical phenomena regulating and limiting system performance and durability. This will be tackled with a combined experimental and modelling approach, further leveraged and supported by the expertise on materials science of DURALYS' partners. The following activities are identified: a) development and experimental validation of a AEMWE physics-based impedance model; b) single cell experimental characterization of AEMWEs performance and degradation under different operating conditions and load profiles, also adopting innovative materials; c) understanding of critical phenomena and development and engineering of solutions to improve AEMWE performance and durability.
Methods and techniques that will be developed and used to carry out the research	The experimental analysis will be carried out through the experimental facilities available at MRT Fuel Cell &Battery Lab research group (https://www.mrtfuelcell.polimi.it/) and Pro-e-Storage interdepartmental laboratory. The experimental analysis will mainly consist of electrochemical characterizations in single cell, such as polarization curves, electrochemical impedance spectroscopy, cyclic voltammetry, accelerated stress tests and load cycles representative of real applications.Modeling analysis will be developed starting from proprietary codes based on Matlab® and/or ANSYS FLUENT to simulate system operation.
Educational objectives	The research topic is extremely interdisciplinary, ranging from material science to the engineering of the electrochemical device. The student will deepen his/her theoretical knowledge in thermodynamics, heat and mass transport phenomena and electrochemistry. The student will develop advanced expertise regarding electrochemical measurement techniques and physics-based modelling. Coordination of graduating students is also expected.

Job opportunities	Placement in enterprises operating in the field of energy storage, materials manufacturing, electrochemistry, modelling of energy systems. The acquired experience permits to continue the research career in academia and in research centres.
Composition of the research group	1 Full Professors 3 Associated Professors 0 Assistant Professors 9 PhD Students
Name of the research directors	Andrea Baricci, Matteo Zago

Contacts
andrea.baricci@polimi.it matteo.zago@polimi.it +39-02-2399-3840 www.mrtfuelcell.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	800.0 €
By number of months	6

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

Educational activities: Financial aid per PhD student is available for purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences, instrumentations and computer, etc. This amount is equal to 10% of the annual gross amount, for 3 years.

Teaching assistantship: Availability of funding in recognition of supporting teaching activities by the PhD student. 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.

Computer availability: individual use.

Desk availability: individual use.

Awards: none.