



PhD in SCIENZE E TECNOLOGIE ENERGETICHE E NUCLEARI / ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY - 38th cycle

PARTENARIATO PNRR Research Field: ELECTRIFIED CATALYTIC REACTORS FOR HYDROGEN STORAGE AND PRODUCTION

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

CUP D43C22001410007

Decreto di concessione D.D. 1055 del 23/06/2022

D.D. 3277 del 30/12/2021 Avviso pubblico per la presentazione di Proposte di intervento per la creazione di 12 Ecosistemi dell'innovazione sul territorio nazionale da finanziare nell'ambito del Piano Nazionale di Ripresa e Resilienza, Missione 4 Componente 2 Investimento 1.5 - Creazione e rafforzamento di "ecosistemi dell'innovazione", costruzione di "leader territoriali di R&S" - finanziato dall'Unione europea - NextGenerationEU.

Electrification of hydrogen production processes can play a key role in energy transition strategies. In addition to water electrolysis several catalytic processes can be electrified to cover the energy load of the relevant reaction network. In this respect electrification of methane steam reforming and methane pyrolysis is being extensively investigated. Another option to couple electrical energy with chemical processes pertains to the use of hydrogen carriers (e.g. Liquid Organic Hydrogen Carriers-LOHC, ammonia,...), which undergoes reversible hydrogenation and dehydrogenation cycles through exo-endothermic catalytic steps.

The design of catalytic reactors able to effectively couple the electrical energy input with the enthalpy demand of the chemical processes requires the development of novel



	<p>reactor concepts able to optimise the interplay between kinetic and thermodynamic features of the catalytic reactions with heat and mass transfer aspects associated with peculiar energy delivery methods. Such interplay can take advantage from the characteristics of structured catalysts and reactors, which have been thoroughly investigated by the Laboratory of Catalysis and Catalytic Processes (LCCP) research group in the recent years. The aim of this project is to investigate the potential of electrified structured catalytic reactors in hydrogen storage and production processes also considering dynamic aspects associated with coupling with the electrical grid and load requirements of specific hydrogen users (engines, fuel cells,?).</p>
Methods and techniques that will be developed and used to carry out the research	<p>The relevant catalytic processes will be first investigated by mathematical models of the electrified reactors consisting of mass, energy and momentum balances able to describe the interplay between chemical reactions and transport phenomena. Such activity will allow to identify and preliminary design promising reactor concepts. Particular emphasis will be given to dynamic aspects associated with transient/intermittent reactor operation modes.</p> <p>The most promising options emerging from the modelling activity will be tested through the experimental facilities available at LCCP research group. Experimental tests could also be performed to collect catalytic kinetics and transport properties input needed for the modelling activity.</p>
Educational objectives	<p>The student will deepen his/her knowledge in thermodynamics, mass and heat transfer, kinetics aspects associated with catalytic processes, as well as on mathematical modelling of catalytic reactors and experimental activities.</p>
Job opportunities	<p>Placement in companies operating in the field of energy and chemical industry.</p>



Composition of the research group	6 Full Professors 5 Associated Professors 2 Assistant Professors 20 PhD Students
Name of the research directors	Gianpiero Groppi, Alessandra Beretta

Contacts
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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
<p>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.</p> <p>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.</p> <p>Computer availability: individual use.</p> <p>Desk availability: individual use.</p>