SUSTAINABLE MATERIALS, PROCESSES AND SYSTEMS FOR ENERGY TRANSITION

Photocatalytic CO2 reduction with well-defined nanostructures

Funded By	FONDAZIONE ISTITUTO ITALIANO DI TECNOLOGIA [P.iva/CF:09198791007]
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Context of the research activity	Photocatalytic carbon dioxide (CO2) reduction is a promising strategy to solve the energy crisis and to take a step towards a circular economy. The production of solar fuels is triggered through the absorption of light, the charge separation and their transfer to reduce CO2. With this PhD we target to develop methods for the light-driven CO2 reduction by implementing well-defined nanostructures with the major target of producing alcohols and hydrocarbons.
Objectives	Scholarship funded by IIT. Main seat to carry out the research: Istituto Italiano di Tecnologia, Genova Supervisors: Ilka Kriegel, ilka.kriegel@iit.it - Liberato Manna, liberato.manna@iit.it - Michele Ferri, michele.ferri@iit.it Contact: Iulia Manolache, iulia.manolache@iit.it One critical point that limit progress and practical applications of photo- and/or electrocatalytic CO2 reduction is related to the poor product selectivity and the difficulty in producing high-added value C-based products such as alcohols and/orhydrocarbons. Deep understanding of the fundamental processes of CO2 reduction reaction mechanism are key to tune the product selectivity. Photocatalytic CO2 reduction reactions are multi-electron transfer reactions. Hence, one important step towards the production of highly reduced C-based products is to tune the binding energy of intermediates to foster multiple electron transfers. This dynamically influences the rate of surface catalytic reactions and ultimately the product selectivity. In this PhD program, the successful candidate will focus on the implementation of complete photocatalytic, photoelectrocatalytic and spectroelectrochemical systems for the testing of nanostructured catalysts for CO2 photo(electrochemical) reduction. The candidate will be working on photocatalytic reactors and photoelectrochemical cells, through which they

	will unravel the underpinnings of CO2 reduction activity and selectivity of the materials under study (typical materials of interest include perovskites, doped metal oxides, transition metal dichalcogenides and their heterostructures). Throughout their experiments, the candidate will be actively involved not only on the photoelectrochemical/catalytic characterization of the materials but also on the synthesis, structural/morphological characterization of materials and products analysis. Where useful, the results will be accompanied by simulations with numerical and empirical tools. Overall, the main focus of this PhD position will be the identification of structure-activity relationships of novel catalysts for the photo(electro)chemical CO2 reduction, aiming to the highly selective production of high added-value C-based molecules from CO2 through a deeper comprehension of the related photo(electro)catalytic phenomena and process optimization. Strong collaboration with fellow PhD students of the same institute and PhD program is foreseen.

Skills and competencies for the development of the activity	Chemistry, physics, natural sciences, engineering or similar qualification Experience with photocatalysis, photoelectrochemistry, nanochemistry or spectroscopy would be a plus Interest in learning new topics Collaborative working attitude Interdisciplinary research approach Ability to work in an international research environment