ISTITUTO DI CHIMICA DEI COMPOSTI ORGANOMETALLICI

Consiglio Nazionale delle Ricerche

Venerdì, 23/04/2021
alle ore 11.30

il Dr. Marco Bellini
CNR-ICCOM
Firenze

terrà il seguente seminario:

"Electrocatalysis for Energy: from a nanosized to molecular approach"

Il seminario sarà tenuto in modalità telematica, tramite accesso alla piattaforma:
GoToMeeting

Si invitano tutti gli interessati a partecipare.

Dr. Francesco Vizza
Direttore ICCOM

Short Abstract:

Hydrogen has the largest energy density of all fuels and is considered the more suitable energy source (properly H_2 is an energy vector) for matching a clean and carbon neutral future energetic scenario. This rather old technology was theorized almost 50 years ago but still doesn't have a widespread application due to severe limitations. The high cost and the poor sustainability for large scale application of electrochemical devices for hydrogen production and conversion to electricity are the main limitations. In fact, proton exchange membrane electrolyzers (PEMs) and fuel cells (PEMFCs) employ catalysts based on high amounts of rare noble metals, such as Pt, Ir, Ru and Pd. In addition, proton exchange membranes, such as the DuPont Nafion®, are very expensive materials.

The reduction of precious metal loadings to negligible amounts keeping constant catalyst activity is a possible route for making fuel cells and electrolyzers sustainable devices. Traditional electrocatalysts are based on metal nanoparticles dispersed on conductive supports where only the particles surface atoms are involved in electrocatalysis. Replacing nanoparticles with metal complexes is a way for making accessible each metal center of the catalyst. A molecular catalyst offers other advantages with respect to nanosized materials, such as control of the selectivity of the oxidation reaction occurring in direct fuel cells fed with liquid and renewable fuels such as alcohols and formic acid. So direct fuel cells can convert a biomass-derived fuel not only into electricity but also into high purity chemicals.

A second route to make fuel cells and electrolyzers sustainable devices is the replacement of proton exchange membranes with anion exchange membranes (AEMs) because in alkaline environment several nanostructured catalysts based on cheap metals can be used (in acidic environment most of the transition metals would be subject to corrosion phenomena). Thanks to the development over the last few years of high efficiency and stable alkaline membranes, we have developed anodic and cathodic nanostructured catalysts based on cheap metals like iron and nickel which are assembled together in alkaline fuel cells and eletrolyzers able to reach an activity close to the state of the art PEM based devices. As example an iron phthalocyanine cathode based H_2/O_2 fed fuel cell set up in our laboratory delivered a remarkable power density of 1 W cm^{-2}.

Biographic sketch:

Marco Bellini obtained his Master's degree in chemistry at the University of Florence in April 2012 and in September began a Ph.D. fellowship (September 2012-January 2016) in Chemistry at the University of Florence in collaboration with the Institute of Chemistry of Organometallic Compounds (ICCOM) of the Italian National Research Council (CNR) in Sesto Fiorentino. Since his master thesis, Marco has investigated the "dark matter" for chemists: electrochemistry. During his Ph.D. he focused his research on electrochemistry applied to renewable energy, studying direct alcohol fuel cells and alkaline alcohol electroreformers for sustainable H_2 generation. He focused attention on organometallic electrocatalysts in collaboration with Prof. Hansjörg Grützmacher of ETH of Zürich where Marco spend a training period in February 2014. His research on molecular catalysts for energy production was rewarded with the 2017 Eur-JIC prize for innovation in organometallics. In June 2014, Marco visited San Cristòbal de la Laguna at the Univeristy of La Laguna (Tenerife, Spain) in the framework of the European project Decore, studying the electrochemical behavior of platinum free direct alcohol fuel cells at intermediate operating temperatures and pressures. From January 2016 to December 2019 Marco was a Post-doctoral fellow at ICCOM-CNR under the supervision of Dr. Francesco Vizza and Dr. Hamish Miller. Marco extended his research experience to the development of precious metal free alkaline membrane electrolysis and to precious metal free alkaline H_2/O_2 fed fuel cells including a collaboration with Prof. John Varcoe of the University of Surrey in Guildford (United Kingdom), where Marco spent a month as invited researcher in January 2018 in the framework of a bilateral exchange project between CNR and Surrey. Marco was appointed as researcher at ICCOM-CNR in December 2019 and is studying the development of precious metal free and molecular based electrocatalysts for fuel cells and electrolyzers. Marco has an h-index of 13, he is author and co-author of 29 publications in peer-reviewed journals and he is the author of several communications at national and international conferences.