SINCHEM doctoral research subject

Development of Innovative Electrodes for the electrocatalytic conversion of small molecules

Electrocatalysis is a key element for the development of sustainable chemical processes utilizing renewable energy. This general area is indicated as “Solar-driven chemistry”, where the term “solar” indicates all the challenging new area of syntheses where the energy to drive the reaction is not provided by fossil fuels (i.e. thermal energy). Electrocatalysis is at the core of this challenge, where the term electrocatalysis indicates the possibility to drive the electrochemical reactions through the use of catalysis concepts which will allow to i) lower the energy (i.e. reduce the overpotential and loss of energy), ii) improve the Faradaic efficiency and iii) especially control the selectivity.

A specific challenge is related to the development of novel electrocatalysts/electrodes with the aim to combine both above aspect to another which is the key aspect to move to industrial applications: improve the productivity of the electrodes, reducing thus the fixed costs (a key aspect). In this project, we will explore new type of electrodes, indicated with the term 3D-type to remark the differences with respect to the near-flat type of conventional electrodes for electrochemical syntheses. We will use from one side MOF-type electrodes, to take advantages of the possibility to realize high-surface electrodes, with well-defined type of active catalytic sites. The other type of 3D-type electrodes will be based on metal nanoparticles (without noble metals), including sub-nano type, deposed over different types of nanocarbons and a 3D-type conductive carbon substrate.

Two very challenging reactions will be investigated: the reduction of CO_2 to fuels and the reduction of N_2 to ammonia. The PhD thesis will be in collaboration with CNRS-CPE Lyon, expert in the synthesis of nanomaterials and MOFs. The PhD thesis will investigate i) the synthesis and advanced characterization (using a combination of techniques) of the electrocatalysts/electrodes, ii) the electrochemical characterization of these materials, iii) the testing of the two cited reactions in flow-type electrocatalytic reactors of new design.

Candidate:

The ideal candidate should have a solid background in the synthesis of nanomaterials and electrodes, and in the testing of catalysts, with good bases on the electrochemical methodologies.

Supervisors:

In **MESSINA** (Italy – *HOME Location*): prof. Siglinda PERATHONER, prof. Gabriele CENTI (UNIME)

In **LYON** (France – *HOST Location*): Dr. E.A. QUADRELLI (LYON 1 University – C2P2 Unit – UMR 5265 CPE-CNRS-Unily1)

An *ASSOCIATE Location* will be defined later.