International Doctoral Program in Science Position

Supersonic cluster beam deposition of nanoalloys and bimetallic nanostructures for enhanced oxygen evolution reaction

Background and motivation

Hydrogen is considered the best alternative to fossil fuels, and H production with no greenhouse gas emissions can be obtained in photoelectrochemical water splitting, by using materials to dissociate water molecules into H and oxygen exploiting light. The intrinsic slow kinetics of these oxygen evolution reaction (OER) is a major obstacle towards efficient photoelectrochemical cells. Various combinations of metals, oxides and alloys have been investigated as catalysts to improve OER kinetics. Bi-metallic or alloy electrodes are now attracting a great interest as alternatives to the expensive Ru and Ir-based catalysts.

We recently demonstrated that $Au_{0.89}Fe_{0.11}$ nanoalloys exhibit strongly enhanced OER in comparison to the individual parent-metal nanoparticles (NP). Such a remarkable electrocatalytic activity is associated to nanoalloying. These results open attractive scenarios to the use of kinetically stable nanoalloys for catalysis and energy conversion, in particular if one is able to synthesize NPs with tunable concentration of the composing materials. We are able to deposit NP with controllable size, chemical composition and relative concentration of the constituents directly on the electrodes by supersonic cluster beam deposition (SCBD). Aim of the project is to investigate the relationship between the granular film physical properties and the OER behavior of nanostructured electrodes for different type of bimetallic systems, such as Ag/Fe, Au/Fe, and Ni/Fe-based compounds.

Bimetallic systems will also be studied at ND to exploit localized surface plasmon resonance for a new generation of photo- and electrophotocatalysts, which can combine the excitation of hot-electrons and high selectivity to achieve unprecedented catalytic efficiency. The surface-enhanced vibrational spectroscopy and NP optical properties will provide insightful information on the mechanisms of energy transfer at the nanoscale. New strategies based on Mie-type resonators and dielectric optical nanoantennas will be also utilized to enable real-time monitoring of the reactions under non-invasive conditions.

Profile

- Diploma: Master's degree or comparable qualification in Physics, Materials Science, Chemistry or adjacent fields. The title must be obtained before OCTOBER 31ST 2019.
- A solid background in physics, materials science or materials chemistry is required
- A strong interest for multidisciplinary research is required.
- Good knowledge of the English language, both spoken and written, is essential.
- Strong commitment, ability to work in a team, and eagerness for international mobility is desired.

Opportunities

- Participating to an international collaboration between Università Cattolica del Sacro Cuore and Università degli Studi di Brescia (Italy), Notre Dame (USA)
- Double degree opportunity.
- This position is supported by a fellowship of 15.343 (gross income) per year. The monthly allowance is increased by 50% when students are abroad.

Supervisors

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