Position available at Istituto dei Materiali per l'Elettronica e il Magnetismo (IMEM-CNR) in Genova.

Duration: 12 months (extendable to 24 months)

TOPIC: Growth and characterization of mono- and bi-metallic nanoscluters as model systems for biomass conversion

Project description

Bimetallic nanoclusters (bNCs) are at the forefront of research in chemical physics for their peculiar structural, electronic and catalytic properties, which are different with respect to those of bulk materials and alloys and of mono-metallic nanoparticles. The capability to control their size and composition allows to tune their properties and to optimize the use of precious metals, which are often of high cost and difficult supply. In addition, the interaction with a solid support may affect their shape, charge state and electronic structure.

Ultrasmall particles represent the ultimate limit for the optimal use of precious materials due to their extremely large surface to volume ratio. In this limit, moreover, the simplicity of the nanoclusters shape leads to a higher selectivity, while a larger fraction of atoms are located at the cluster/substrate interface and are chemically modified by their bonding with the substrate.

We intend to study the physical and chemical properties of bi-metallic nanoclusters used for the conversion of biomasses. If derived from wood and agricultural residues, biomasses are often rich in lignin, cellulose and hemicellulose, which are an excellent base for the production of fuel and chemicals, but have a large oxygen content. The latter can be reduced by dehydration and hydrodeoxygenation, for which reactions bi-metallic nanoclusters are promising catalysts.

We will investigate these processes on well-defined model systems using advanced experimental methods of surface and material science as scanning probe microscopy (STM/STS and AFM), photoemission and vibrational electron-based spectroscopies, and thermal desorption spectroscopy. Pt-Zn, Ru-Cu and Cu-Pt bi-metallic nanoclusters of ultra-small size grown in-situ on MgO or graphene supports will be exposed to very simple reactants (e.g. ethylene glycol and benzaldehyde) containing some of the functional groups (OH, C=O) involved in the deoxidation processes occurring in biomass conversion.

Specific activities will include:

- Preparation of the samples:
    - growth of MgO films;
    - deposition of metallic nanoclusters – search for the best deposition conditions;
    - exposure of selected systems to reactants.
- Characterization of the systems in the different stages of preparation by one or more of the following experimental techniques:
    - LT-STM/STS
    - XPS
    - AFM
    - HREELS

- TDS

Context

The position is open in the frame of the PRIN2022-PNRR Project Bi-NANO: "Bi-metallic nanoclusters for catalytic biomass upgrade: investigating model systems at the atomic scale". The project is lead by the IMEM-CNR unit in Genova, that will act in strict collaboration with the Surface Science group of the Physics Department in Genova and the theoretical group of Prof. Sergio Tosoni at the Material Science Dept. in Università Milano Bicocca. The research team presents complementary competences and has already established a fruitful and longstanding collaboration that is beneficial to the project development. The candidate will take advantage of this strong cooperation and he/she will acquire and develop green skills in that interdisciplinary area at the border between physics and chemistry.
The selection will be carried out respecting a balance of gender, ethnical, and geographical diversity.

Skills required

The ideal candidate profile includes:

- Previous experience with at least with one of the mentioned experimental techniques.
- Basic knowledge of ultra-high vacuum apparatuses.
- Knowledge in surface/material science, in particular in the growth and characterization of low-dimensional systems.

Interested candidates are welcome to contact Dr. Letizia Savio (letizia.savio@cnr.it) for further information.