

Research grant / post-doctoral position available at the Physics Department of Physics of Università degli Studi di Genova.

Duration: 12 months (extendable to 24 months)

TOPIC: Growth and characterization of supported ultra-small metal clusters for catalytic reactions

Project description

Most heterogeneous catalysts consist of small, supported metal particles on nominally inert substrates. However, these particles have a size dispersion and they expose different facets, undercoordinated sites and defects, that allow for different reaction pathways and final products and that may limit the catalyst selectivity. Moreover, atoms inside the active particles are not exposed to the reactants and hence represent a waste of precious material.

Reducing the particle size decreases their complexity and increases the fraction of catalytically active atoms, but it may also change their electronic and chemical properties. For this reason, it is mandatory to explore them in the ultra-small limit.

We plan to investigate experimentally the chemical activity of ultra-small Ni and Pd nanoclusters supported on MgO ultrathin films with respect to reactions of paramount relevance for green chemistry and fine synthesis, i.e. CO₂ methanation, methane oxidation to methanol, and steam reforming. These reactions deal with the usage of harmful greenhouse gases (CO₂, CH₄) and with the prototypical activation of very stable C-O and C-H bonds.

Aggregates of Ni and Pd atoms will be deposited on the surface of MgO films supported on Ag(100) under ultra-high vacuum conditions and the clusters will be characterized by state-of-the-art experimental surface science techniques as scanning probe microscopies (STM and AFM) and electron based spectroscopies (XPS, STS, HREELS).

We will explore the reactivity of Ni and Pd clusters both toward reduction (CO₂ methanation) and oxidation (methane oxidation and steam reforming) reactions, based on the different affinity to oxygen displayed by Ni and Pd and aiming at performing different processes on the same, well-defined catalytic system.

Specific activities will include:

- Preparation of the samples:
 - o growth of MgO films;
 - o deposition of ultra-small metal clusters;
 - o exposure to reactants.
- Characterization of the systems in the different phases of preparation by one or more of the following experimental techniques:
 - o LT-STM/STS
 - o XPS
 - o AFM
 - o HREELS

in order to correlate the cluster properties (geometry, oxidation state, electronic structure) with their chemical activity and identify the optimal growth protocol.

Context

The position is open in the frame of the PRIN2022 Project SUMCAR: “Supported Ultra-small Metal clusters for CAlytic Reactions”.

The project foresees a strict collaboration among the Surface Science group at the Physics Department in Genova, the IMEM-CNR research unit in Genova and the theoretical group of Prof. Sergio Tosoni at the Material Science Dept. in Università Milano Bicocca. It will take advantage of the previous, longstanding collaboration and common works carried out by the Team members.

The candidate will benefit of the strong cooperation between complementary research groups 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.
- Ph.D. in physics, material science or chemistry (less experience candidates will be evaluated anyway).

Interested candidates are welcome to contact Prof. Mario Rocca (rocca@fisica.unige.it) or Dr. Letizia Savio (letizia.savio@cnr.it) for further information.