CATALYSIS FOR ENVIRONMENTAL PROTECTION AND ENERGY PRODUCTION

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The research activity of the group is mainly focused to the preparation and characterization of heterogeneous catalysts with special interest devoted to their applications in the fields of environmental protection and energy production

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1. Catalytic removal of Volatile Organic Compounds (VOC) over gold catalysts
   It is well known that gold is inert in its bulk form, whereas when it is highly dispersed (diameters < 5 nm) it becomes highly active for oxidation reactions. The activity has been found to strongly depend on both the Au particle size and the support nature. In this context our research deals with the effect that preparation (impregnation, ion-exchange, coprecipitation, deposition–precipitation) and pretreatment conditions have towards the performances of supported gold catalysts in the VOC combustion. Very interesting results were obtained on Au/CeO₂ and Au/Fe₂O₃ systems, which showed a high combustion activity, related to the capacity of gold nanoparticles to weaken the surface Ce-O or Fe-O bonds adjacent to Au atoms, thus enhancing the reactivity of the capping oxygens of reducible oxide, involved in the VOC oxidation through a Mars-van Krevelen mechanism.

2. Hydrogen production through NaBH₄ hydrolysis over supported Ru catalysts
   Hydrogen is considered as a promising carrier for the future energy network. Polymer electrolyte membrane fuel cells (PEMFC) are among the most advanced systems for energy production starting from hydrogen. Nowadays hydrolysis of metal hydrides is receiving special attention as an ideal source of pure hydrogen for PEMFC, specially for portable applications. In this context we are investigating the NaBH₄ hydrolysis over supported Ru nanoparticles, focusing on the effect that different preparation variables (technique, metal precursor, support) can have on the size of Ru nanoparticles and on their catalytic performance.

3. Hydrogen production through catalytic steam reforming of biomasses
   Much attention has been recently devoted to the production of hydrogen from steam reforming of
renewable sources, and notably bio-ethanol. A good ethanol steam reforming catalyst would be one that is active at low temperatures and has a good selectivity for H\textsubscript{2} over H-containing products such as CH\textsubscript{3}CHO, C\textsubscript{2}H\textsubscript{4} and other hydrocarbons. In this context we are investigating the steam reforming of ethanol over different bimetallic catalysts such as Ru-Ni, Rh-Ni, Ru-Co and Rh-Co, prepared by different methods and metal precursors.

4. **Hydrogen purification through preferential oxidation of CO (PROX)**

Selective oxidation of CO in H\textsubscript{2}-rich stream (known as PROX reaction) is regarded as one of the most promising technology to reduce CO concentration to acceptable levels for fuel cells applications. We are now investigating the use of IB metal/ceria and Pt/zeolite catalysts in the PROX reaction, with the aim to enlighten the role played by both the metal and the support in affecting the chemico-physical properties and therefore the performance of the catalytic system.

5. **Preparation of supported metal nanoparticles through photochemical approaches**

The preparation of highly dispersed supported metal catalysts by a photochemical approach, namely the Liquid Phase Photo-deposition (LPPD), has been recently investigated. LPPD involves the chromofores of a complex which absorbs the light producing a photo-excited state which may give, by a photo-redox reaction, metal nanoparticles able to spread over the substrate surface. The main advantages of this approach are the short reaction time, the high reproducibility, the use of a clean reagent as the light source and very narrow metal size distribution, which appears appropriate for the destruction of VOC.

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**Collaborations and Research Grants**

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**Selected Recent Publications**