CATALYSIS FOR ENVIRONMENTAL PROTECTION AND ENERGY PRODUCTION

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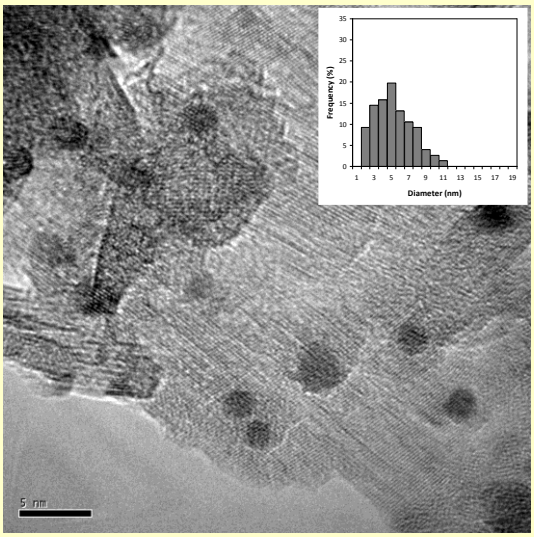

Fig.1 TEM image and Pd particle size distribution of a Pd/alumina catalyst prepared by LPPD

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

Keywords: Heterogeneous catalysis, Green chemistry, Energy, Hydrogen, Nanoparticles.

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/CeO_2 and Au/Fe_2O_3 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 $NaBH_4$ 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 $NaBH_4$ 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_2 over H-containing products such as CH_3CHO, C_2H_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_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 chromofore 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, the possibility to work at room temperature with simple and low cost equipments. We have found that this approach results in supported Pt, Pd and Ag catalysts with an homogeneous and very narrow metal size distribution, which appears appropriate for the destruction of VOC.

Collaborations and Research Grants

- Dipartimento di Chimica Industriale ed Ingegneria dei Materiali - University of Messina, Italy
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- Istituto per lo Studio dei Materiali Nanostrutturati CNR - Palermo, Italy
- STMicroelectronics, IMS-R&D New Device Technologies Group – Catania, Italy

Selected Recent Publications

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