The Gold Species Supported on Ceria Structured as Nanofibers and Nano Fine Crystals

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Introduction

Gold based catalysts have received wide attention ever since Haruta et. Al., found that supported gold catalysts are extremely active for the oxidation of CO when deposited as nanoparticles on metal oxides [1]. The nature of the support plays a vital role in determining the activity of gold catalysts. It was shown that nanocrystalline ceria is quite effective as a support for gold catalysts [2,3].

At the moment there are different techniques to manufacture ceria as nanofibers, nanorings and nano fine crystals [4]. These structures are expected to have their unusual characteristics amplified through quantum size effects, and marked shape-specific effects.

The aim of the present work was to evaluate the influence of the specificity of ceria nano objects on the properties of gold species supported on these materials.

Materials and Methods

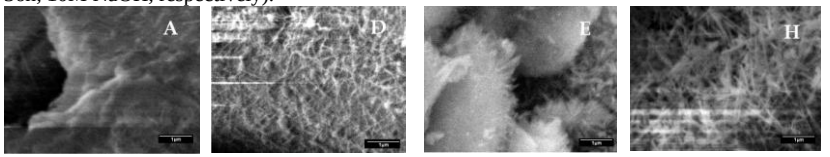
Ceria prepared by sol-gel using citrate complex method as in [5] was treated in autoclave with NaOH varying temperature, time of treatment and concentration of NaOH according to [6]. The obtained samples were washed with water and calcined at 650ºC in air during 4 hours. Gold (3%) was deposited on ceria using DP technique with urea.

Prepared samples were characterized by TEM, SEM, XPS, XRD, UV-vis spectroscopy, titration of available surface oxygen with H_2 pulses at high temperature and in CO catalytic oxidation in flow (mixture 1%CO+0.5%O_2, residence time 30 μmol CO/s/g-CAT).

Results and Discussion

The hydrothermal treatment of ceria in autoclave at different conditions results in the different morphology of ceria crystals (Fig.1). The treated samples are characterized with huge increase of BET surface area (up to 50-70 m^2/g) than that for initial ceria (4m^2/g) accompanied with the decrease in size of primary ceria crystals and gap energy. The latter manifests the increase of the number of structural defects in treated samples. The presence of structural defects on ceria increases the content of reactive surface oxygen and contribution of cationic gold species (Fig.2 and 3), and activity of samples in CO oxidation.

Figure 1. SEM micrographs of some selected ceria samples (A, D, E and H) after different treatments (120ºC, 36h, 10M NaOH; 150ºC, 36h, 5M NaOH; 120ºC, 48h, 5M NaOH; 150ºC, 36h, 10M NaOH, respectively).



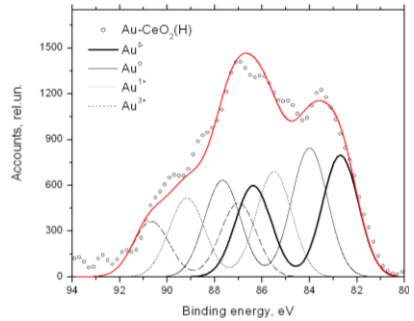


Figure 2. Au 4f $_{7/2}$ XPS spectrum for Au-ceria-H sample prereduced in H_2 at 350ºC.

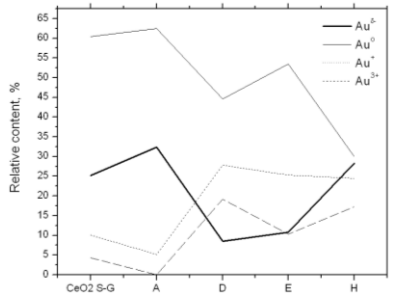


Figure 3. Relative content of different gold species according to XPS data detected in the A, D, E and H samples prereduced in H_2 at 350ºC.

Significance

The development of new nano structured materials is quite promising for the design of new effective catalysts.

Acknowledgements

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