Development of A Simple Chemical Route for Preparation of Silver Nanoparticle Incorporated Mesoporous γ-Alumina nanocomposites

Narendra Nath Ghosh* and Bhanudas Naik

Chemistry Group, Birla Institute of Technology and Science-Pilani, Goa Campus, Zuarinagar, Goa 403726, India

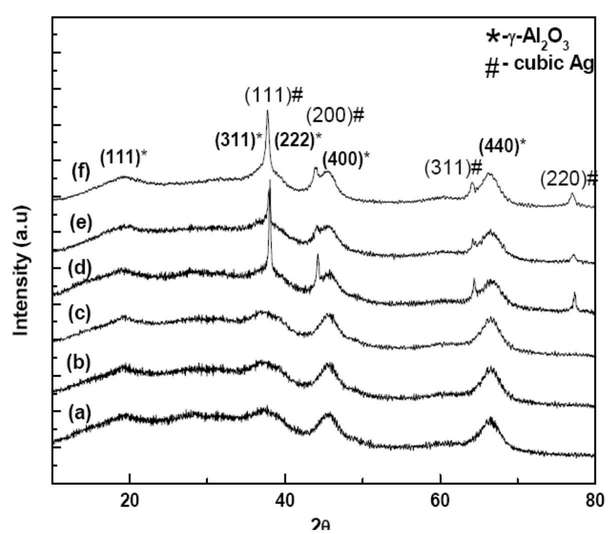
Introduction:

Aluminas, particularly mesoporous γ -alumina, are widely used as catalyst or catalyst support for the numerous chemical reactions. Ag nanoparticle incorporated mesoporous aluminas are more fascinating because of their interesting catalytic, antibacterial, electronic, magnetic, optical, thermal and biosensor properties. $Ag/\gamma\text{–}Al_2O_3$ is a promising catalyst because of its good resistance against catalytic poisoning and exhibits excellent behavior for NO_x removal, high temperature CH_4-SCR of NO_x from flue gases laden with relatively high SO_2 concentrations. Sol-gel method is the most common method for preparation of alumina. However, it has been reported that, aluminum alkoxides are not only costly but also very reactive. Thus, reactions involving these precursors require solvent mixtures or the addition of chelating agents to control the hydrolysis and condensation rates. The use of organic solvents and autoclave as a reactor make these synthesis processes difficult at industrial scale and expensive[1]. Therefore, development of a simple but cost effective synthetic methodology for preparation of Ag nanoparticle (AgNP) incorporated mesoporous alumina with high surface area and narrow pore size distribution is a major challenge.

In this paper, we have reported the development of a simple and cost-effective aqueous solution based chemical method for preparation of silver nanoparticles (AgNP) incorporated mesoporous γ-alumina.

Experimental:

Mesoporous matrix of γ -aluminas, having different surface area and pore size, was synthesized by using aluminium nitrate and water as the solvent. Different carboxylic acids (stearic acid, oleic acid and lactic acid) with TEA were used as a structure directing agents. Impregnation of Ag nanoparticles within the porous structure of γ-alumina was carried out by simultaneous wet impregnation and chemical reduction of silver nitrate with tri-sodium citrate within the porous structure.



Synthesized materials were characterized by using Thermogravimetric analysis , powder X-Ray diffraction, BET surface area and pore size analysis by nitrogen adsorption- desorption isotherms and TEM.

Fig.2. Nitrogen adsorption-desorption isotherms of (a) Al-OA (b) Al-OA-Ag2 (c) Al-OA-Ag5 and (d) Al-OA-Ag10.

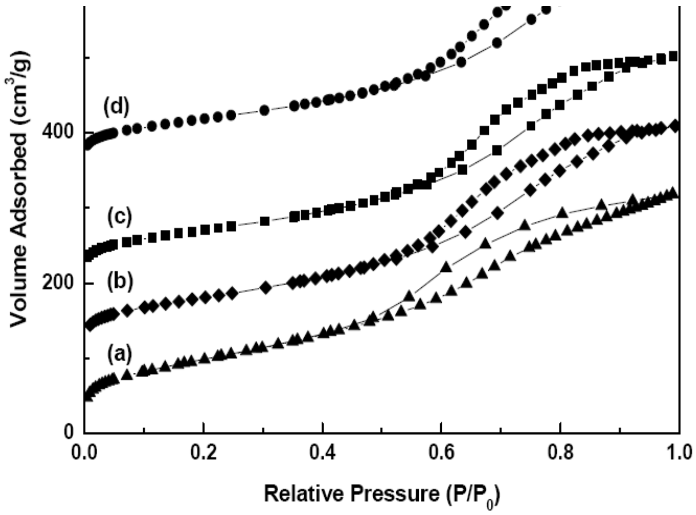
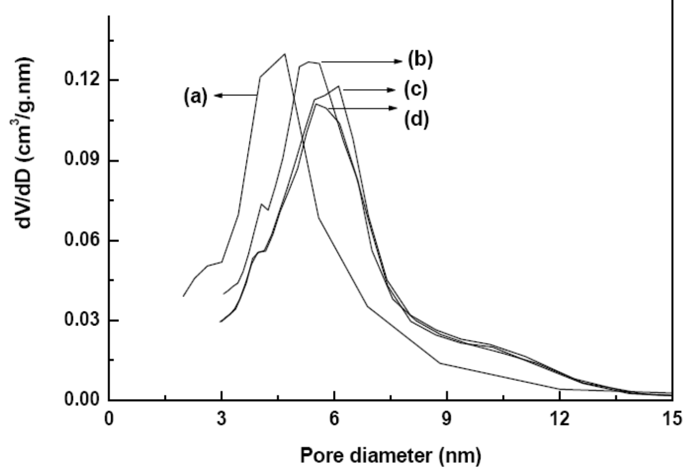


Fig.3. Pore size distribution of (a) Al-OA, (b) Al-OA-Ag2, (c) Al-OA-Ag5 and (d) Al-OA-Ag10.



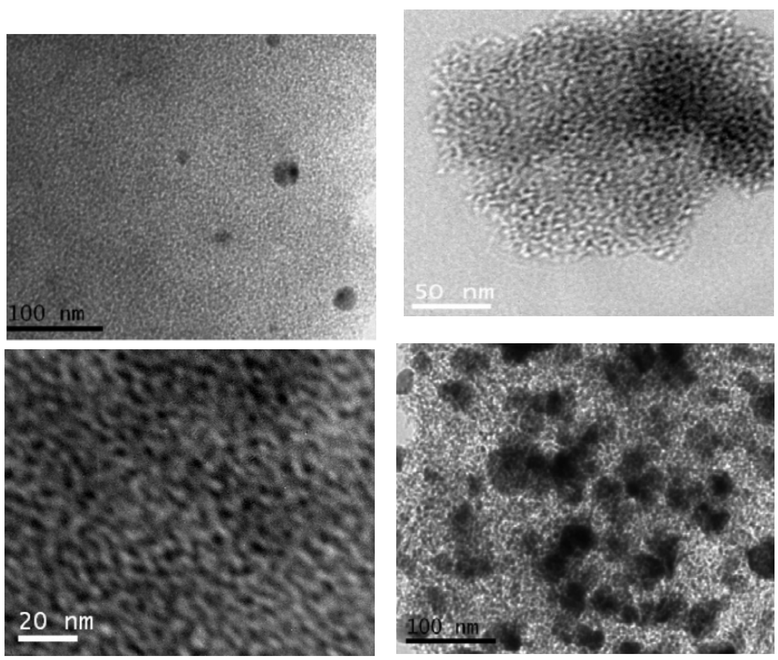


Fig.4. HRTEM micrographs of meso porous alumina and Ag nanoparticle incorporated alumina nanocomposites **.**

Conclusion:

A simple aqueous solution based chemical method has been developed for preparation of silver nanoparticle (~20 nm) incorporated mesoporous alumina (surface area ~300 m^2/gm and pore size ~3- 7 nm) nanocomposites. This method offers several advantages such as (i) here, use of aluminium nitrate instead of reactive and costly aluminium alkoxide, (ii) water as the solvent instead of conventionally used solvent alcohol. These factors make the process cost-effective, (iii) loading of Ag can easily be controlled by simply adjusting the amount of $AgNO_3$ solution. The novelty of this method lies in its simplicity and cost effectiveness.

Reference

1) Naik, B., Prasad, V.S. and Ghosh, N. N. Journal of Porous Materials **17**, (2010): 115–121