

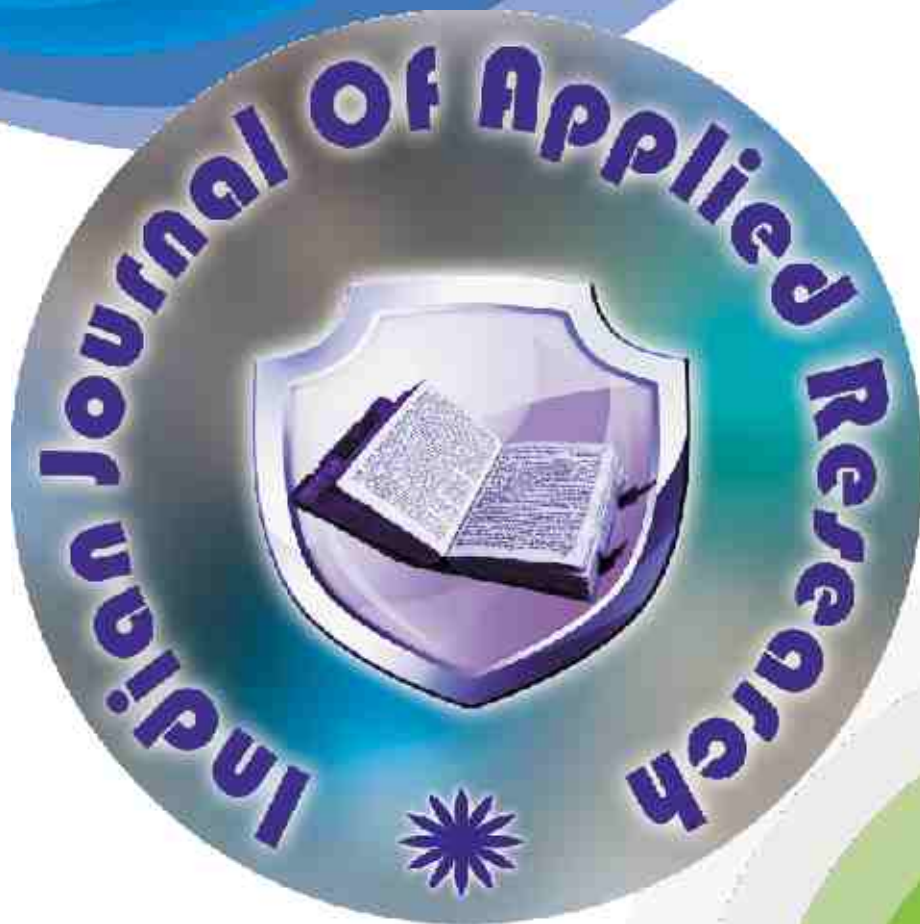
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## Development Of Silver - Silica Nanocomposite For Novel Humidity Sensing Application

\* Surender Duhan

\* Materials Science Lab, Department of Materials Science & Nanotechnology  
Deenbandhu Chhotu Ram University of Science & Technology, Murthal, Sonapat

### ABSTRACT

*The solgel process was successfully prepared Silver/Silica nanocomposites. In this paper, our aim was to development silver -silica nano composites for novel humidity sensing application using sol gel method. The structure of the sample prepared was studied using Ultraviolet Visible Spectroscopy (UV-VIS), Scanning Electron Microscopy (SEM), High Resolution Transmission Electron Microscopy (TEM).*

**Keywords : Ag nanoparticles, silica gel, solgel and temperature**

### Introduction

Synthesis and characterization of nano-sized metallic powders have attracted attention of the materials community due to their promising properties [1-3]. Nanocrystallites depend on the preparation methods; molar ratio of the precursor used and post treatment [2]. In the recent past, nanocrystalline silver oxide/silicates have been synthesized by various methods, e.g. precipitation in high-boiling polyalcohol solutions, inverse micro emulsion, coprecipitation, hydrothermal and solgel auto-combustion [3-7]. The solgel process is a method that is used commercially in many applications, such as forming coatings on window glasses. In addition, it allows higher doping concentrations and a more uniform distribution of metal in the host glass matrix to be achieved [8]. In the present report, we have studied effect of calcinations temperature with prolonged annealing time that mainly supports the development of the silver silicates nanocrystallites in case of silver-containing-silica. The stem of this study is in the results of our earlier report [9], in which, we demonstrated the effect of temperature and time on  $\text{Nd}_2\text{O}_3\text{-SiO}_2$  nanocomposites. The annealing temperature and time dependence of the formation of  $\text{Nd}_2\text{O}_3$  nanocrystallites as well as their distribution in fused silica matrix were observed. We found that the average size of the silver nanocrystallites in a silica matrix was ~50 nm. The Ultraviolet Visible Spectroscopy (UV-VIS), Scanning Electron Microscopy (SEM), High Resolution Transmission Electron Microscopy (HRTEM) data for silver silicates is presented.

### Experimental

The principle and basic technique of the solgel process were described in detail in Ref. [9]. Silver oxide/silicates were prepared by mixing high purity reagents ( $\text{CH}_3\text{CH}_2\text{O}$ )<sub>4</sub>Si (TEOS) Tetraethoxy silane (Aldrich 99.999), ethanol (Aldrich 99.9995), and deionized water. (0.1-1 wt %) of  $\text{AgNO}_3$  was introduced in the pre-hydrolyzed solution. Densification of the prepared samples was obtained by annealing in air, at different temperatures (100 and 500°C) and time (1h).

### Results

#### Optical

Fig. 1 shows the UV-VIS spectra of silver nanoparticles prepared with different initial  $\text{AgNO}_3$  concentrations (0.1 wt % and 1 wt %). The color of the solutions depended on the

concentration of added  $\text{AgNO}_3$  solutions. With increasing the initial  $\text{AgNO}_3$  concentration, the color of solution changed from yellow to brown. The absorption peak at around 400 nm in Fig. 1 is attributed to the surface plasmon excitation of silver nanospheres, indicating the formation of silver nanoparticles. At low  $\text{AgNO}_3$  concentrations (0.1 wt %), a weak absorption maximum of surface Plasmon peaks was observed at 400 nm, showing that silver nanoparticles were produced at a relatively low concentration. With increasing the  $\text{AgNO}_3$  concentration, the intensity of the maximum Plasmon peak increased, indicating that higher concentrations of silver nanoparticles were formed.

#### Scanning Electron Microscope

Figure 3.2 (a-b) shows SEM images of  $\text{Ag-SiO}_2$  (a) 0.1 wt %  $\text{Ag-SiO}_2$  (b) and 1 wt % respectively. From these figures we can see that doping of Ag led to some structural refinement.  $\text{Ag-SiO}_2$  revealed some faceted nanostructures with decreased crystallite size in low doping (0.1, wt %) and increase in crystalline size in further Ag doping (1 wt %) which has been already confirmed by UV-VIS analysis. As we see from micrograph with doping Ag incorporated on  $\text{SiO}_2$  surface.  $\text{Ag-SiO}_2$  seems somewhat porous in nature.

#### HRTEM Micrographs

Figure 3 (a-b) shows the TEM micrographs of the dispersion of silver nanoparticles in  $\text{SiO}_2$  matrix. The nanoparticles with a mean size close to 13 nm were observed in micrograph (a). In the 1wt % Ag-doped  $\text{SiO}_2$  sample shown in TEM micrograph 3 (b), nanograins with a mean grain size of around 15 nm were observed. In further high doping of  $\text{AgSiO}_2$  sample shown in TEM micrograph 3 (b) with a mean grain size of around 20 nm were observed which was also justified by UV-VIS and SEM data. TEM micrograph some flakes of Ag are also shown which is due to the high doping of silver

### Conclusions

The solgel process successfully prepared silver-doped silica samples. The samples were characterized by UV-VIS-NIR, SEM, and HRTEM, and the formation of  $\text{Ag/SiO}_2$  nanocomposites was confirmed. It is found that the evolution of the system as a function of the annealing temperature and doping percentage is necessary for obtaining a nanoclusters distribution in silica matrix.

Figure 1: UV-VIS absorption spectra of the (0.1 wt % and 1 wt %) initial concentrations  $\text{AgNO}_3$ .

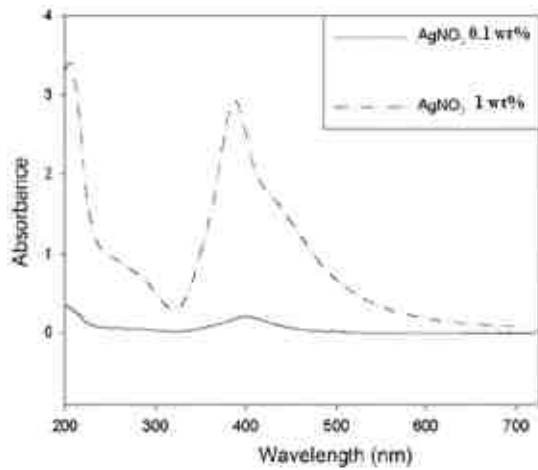


Figure 2: SEM photograph of different amount of  $\text{AgNO}_3$ -doped at (a)  $100^\circ\text{C}$  (0.1 wt %), and (b)  $500^\circ\text{C}$  (1 wt %), respectively.

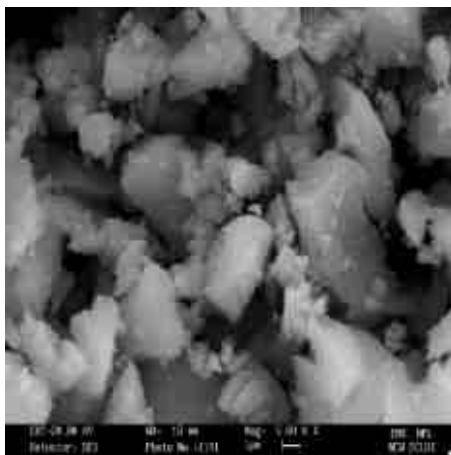
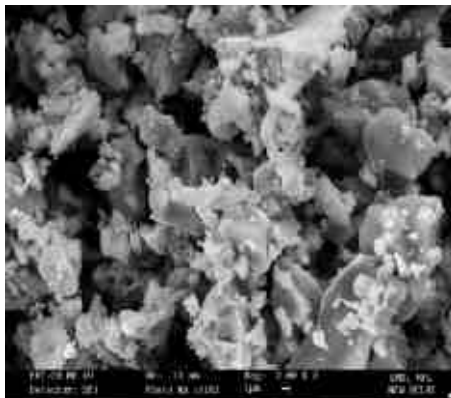
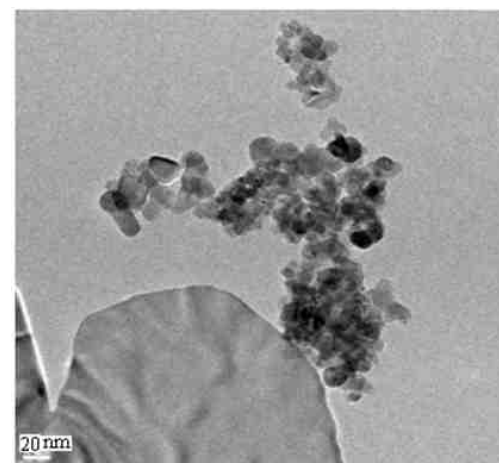
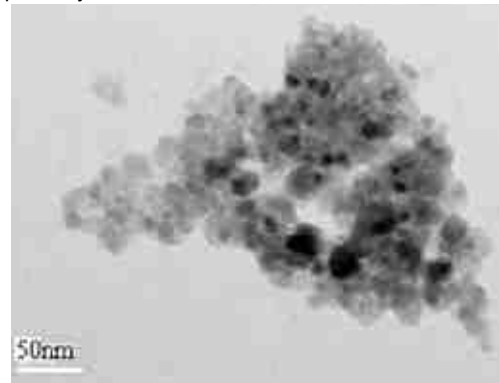


Figure 3 TEM micrographs showing the dispersion of silver in  $\text{SiO}_2$  matrix (a)  $100^\circ\text{C}$  (0.1 wt %), and (b)  $500^\circ\text{C}$  (1 wt %), respectively.



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