SYNTHESIS OF SILVER NANOPARTICLES AND STABILIZATION IN DIFFERENT LIQUID AND SOLID SOL-GEL MATRICES. OPTICAL AND STRUCTURAL CHARACTERIZATION.

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Nano-sized clusters of noble metals in a dielectric media have attracted much attention due to their potential applications in many areas including nonlinear optical devices, surface-enhanced Raman spectroscopy, near-field scanning optical microscopy, biological sensing, heterogeneous catalysis, anti-reflective films, solar cells, light-emitting diodes and integrated optics. Metal nanoparticles dispersed in dielectric materials exhibit a strong characteristic extinction peak, due to plasmon resonance occurring nearly at 420nm in the visible region of optical spectrum. Surface plasmons are collective oscillations of the electrons of conductors leading to a resonant interaction between incident light and the conductor. Metal nanoparticles can result in strong scattering of incident light and greatly enhanced local fields, and can also lead to enhanced fluorescence [1].

Nanoparticle clusters of noble metals can be introduced into a various dielectric matrix, in polymers and sol–gel glasses. In recent years, sol–gel synthesis of nano-composites containing ultra fine particles of noble metals in silica and titania matrices has developed rapidly. The sol-gel technology has advantages in the formation of films with controllable thickness, three dimensional protection of the NCs, prevention of NCs growth, aggregation and oxidation.

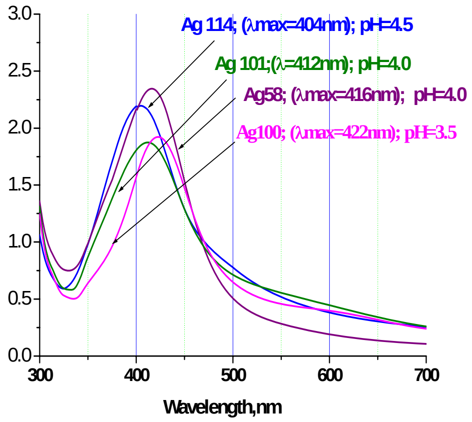
In this work we present simple procedures for the synthesis of various size Silver nanoparticles(NPs) and experimental results about influences of surrounding sol-gel materials on optical and structural properties of synthesized silver nanoparticles (NPs). Various size of silver NPs were obtained in water using citric acid, ammonium hydroxide and/or ascorbic acid at various pH, and stabilized in different sol-gel colloidal solutions. As host sol-gel materials were choose ormosils composite matrices such as: Silica-Polyurethane (SiPU), Zirconia-Glymo (ZrGl) and Glymo- Phenylsiloxane-Polyurethane (GPSPU).

Recently was shown [2] that, in suspension of silver colloids made with well-defined sizes and low heterogeneity, the resonance peak shifts to longer wavelengths when the particle size increases. In this work we estimate the silver NPs size and shape in various sol-gel solutions and solid films from measured absorption spectra and SEM measurements. Absorption spectra of silver NPs obtained in various pH and using different reducing conditions show the above mentioned resonance shifts which correspondence to the increase of the particles size (Figures 1-2). SEM structural characterization of ormosils solid films included silver NPs show homogeneous and well-dispersed silver NPs. Maximum size of the silver grains that could be accommodated in the amorphous matrix were observed to be 62-64 nm. In all matrices particles size obtained by SEM were identical to those which were estimated from the corresponding absorption spectra. Finally, we conclude that it is possible to control silver NPs size at various pH and reducing conditions. Obtained silver NPs can be stabilized in appropriated sol-gel ormosils solution and solid films without changing their optical properties for a long time.

References:

[1] R. Reisfeld · Ts. Saraidarov · V. Levchenko, J Sol-Gel Sci Technol, 50 (2009)194–200.
[2] Lakowicz Joseph R, Krishanu Ray, Mustafa Chowdhury, Henryk Szmacinski, Yi Fu, Jian Zhang, Kazimierz Nowaczyk, R Soc Chem Anal, 133 (2008)1308–1346.

Figures1: Absorbance spectra of silver NPs obtained with ascorbic acid at various pH (3.5-4.5).



Figures 2: Absorbance spectra of silver NPs obtained with citric acid at various pH (6.5-7.5).