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Synthesis and Characterization of Some Silver Nanoparticles

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Abstract

This paper presents methodological stages for obtaining of some investigated silver nanoparticles that were prepared by chemical reduction. AgNp concentration was varied in between 5 and 100ppm. Absorption spectra were plotted for all samples in the spectral range 300 -1100 nm. A thin film was deposited silver thickness nanocoloid less than 100 nm. Morpho-structural characterization was performed using an atomic force microscope (AFM) Water Research SPM and film thickness and roughness were determined using Bruker D8 Discover diffractometer.

Keywords: Silver nanoparticles, transmittance, absorbance, atomic force microscope (AFM), sustainability.

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1. INTRODUCTION

Preparation and characterization of novel nanostructures (cubes, disks, plates, prisms, triangles, wires, rods and macroporous) of noble metals, silver and gold, have come a long way of various investigators in many laboratories [1–5] and their uses in catalysis, photography, superconductors, biological labeling, photonics, optoelectronics, super magnets, surface-enhanced Raman scattering detection, environment, sensors, antibacterial activities and antimicrobial, etc. are unlimited [15–18].

Moreover, method of preparation (radiation, photochemical chemical, and electrochemical) [13, 19-22] and experimental conditions such as [reactants], [stabilizer and/or capping agents], pH, temperature, order of mixing of reactants, presence of electrophilic and nucleophilic reagents, nature of capping agents and stabilizers and even the rate of addition of reducing agents are the important parameters which control the morphology, size, shape, color, stability, and physicochemical properties of the advanced nanomaterials [23–25].

Furthermore, chemical reduction is the most frequently applied method for the preparation of stable silver nanoparticles and its colloidal dispersions in water or organic solvents [26–27]. The investigated results could be useful for stakeholders for associated sustainable applications.

2. MATERIAL AND METHODS

In this section are described the applied methodology as well as useful results for relative applied sustainable solutions. In the useful experiment that was investigated by authors for stakeholders a colloid gel was dissolved in one milliliter of distilled water and applied to spin-coater. Before being submitted, samples were made of heat treatment in an oven at a temperature of 60 degrees Celsius for 30 minutes. Deposition parameters were: angular speed: 3000 rpm/min and acceleration 3000 rpm/minute/ second. [1],[2]

Samples were taken on rigid substrate, that is glass. Cleaning optical glass substrates before submitting active layers consisted ultrasonic for 15 minutes in acetone and ethanol. It was then deposited a thin film of silver nanocolloid by "spin-coating" thickness below 100 nm. Such structures have been characterized achieved optically.

However, absorption spectra were traced at room temperature using a UV-VIS spectrophotometer Perkin-Elmer Lambda 35 [3], thin film of silver colloid by "spin-coating", thickness below 100 nm.

Also, the time for this deposit was 60 seconds at rotation of 3000 rev/min and an acceleration of 3000 rev/min/s. Reflectometry curve run on this silver film is shown in next section in figure 1 and figure 2 based on AFM image from the surface.

Morpho-structural characterization was performed using a force microscope atomic (AFM) Water Research SPM and film thickness and roughness were determined a Bruker D8 diffractometer using Discover. The investigated results could be useful for stakeholders for associated sustainable applications.

3. RESULTS AND DISCUSSION

For the investigated working study was used proper technology for X-ray reflectometry.

However, the applied methodology based on X-ray reflectometry is useful for thin films with dimensions up to few tens of microns.

Also, the thickness can be determined using the following formula d that can be determined using the next equation:

$$d = (i-j)\lambda / 2\sin(\omega_i^1 - \omega_j^1) \quad (1)$$

where, i and j are the interference orders, ω_i^1 and ω_j^1 is half the scattering angle. Relation (1) is derived directly from Bragg's law and was first used for the thickness of Keissing [4].

However, the relative reflectometry curve run on thin silver film. It is shown in figure 1 and figure 2, AFM image of the surface.

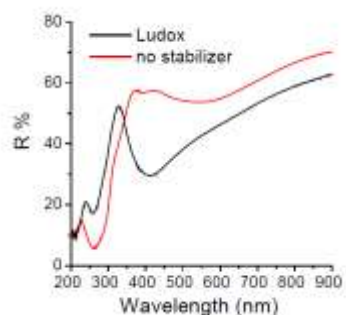


Figure 1. Diffuse reflectance spectra of SiO₂-BP powder after photoreduction of silver in solution with and without Ludox.

In the working study time for this investigated deposit, it was 60 seconds at rotation of 3000 rev/min and an acceleration of 3000 rev/min/s for the relative examining experiment.

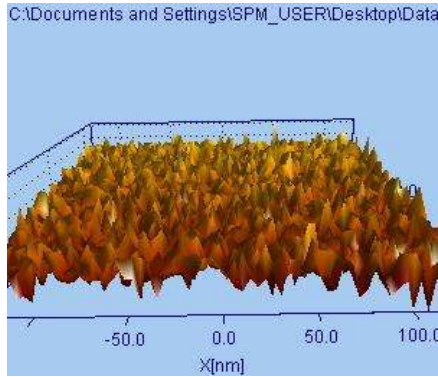


Figure 2. a. The thin film surface image of colloidal silver gel.

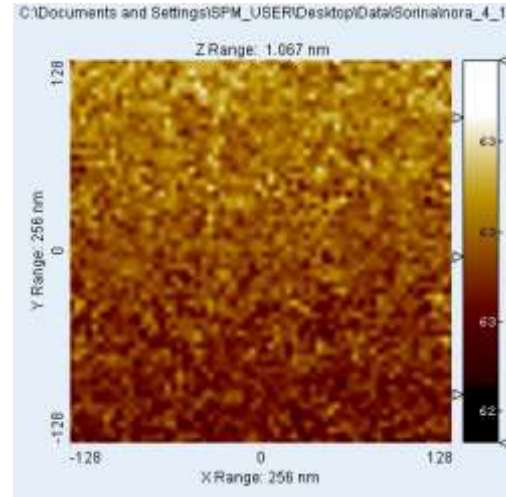


Figure 3. C. AFM image of thin film at 1067 nm.

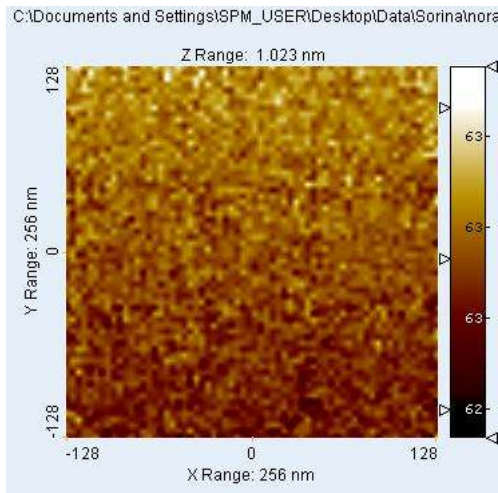


Figure 2. b. The thin film surface image with values obtained at 1023 nm.

Based on the relative analysis of AFM images it presents that values vary between 128 & 63 nm [5].

Analyzing the results it is observed that they are relatively low. This is mainly due to the deposition technique “Spin-coating” of thin films. This technique has the advantage of obtaining layers whose roughness is reduced. For all films deposited, does not exceed 20 nanometers, and this is shown by analysis of surface layers with atomic force microscope.

Applying proper methodology and analyzing images’ results applying proper digital tools can be determined the relative values obtained for the investigated surface images for examining substrates.

Thus applying proper carried technique has the advantage of obtaining layers. In figure 3, is presented the use of proper irradiation of the SiO₂-Ag⁺ or SiO₂-Au³⁺ film in an aqueous solution of BP, SDS, and IPA resulted in the surface plasmon resonance absorption band centered at 408 nm and 514nm from (Ag)_n and (Au)_n nanoparticles [6-10].

However, analyzing in detail the colored values obtained for both thickness and the roughness is advantage of obtaining layers films.

This technique that has applied properly demonstrates useful results for stakeholders. For the analysis of surface layers results could be useful the proper analysis of results processing with the application of atomic force microscope.

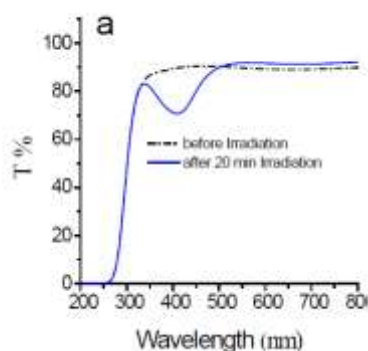


Figure 3. Transmittance spectra of SiO₂-Ag films

This process involves several key steps, including:

- **Image capturing:** High-quality images of the substrates should be captured using a suitable camera or microscope. The images should be taken under consistent lighting conditions to ensure accurate results.
- **Image processing:** The captured images should be processed using digital tools to enhance the contrast and remove any noise or artifacts. This will help in obtaining clear and accurate measurements of the substrate surface.
- **Validation:** It is important to validate the results obtained from image analysis by comparing them with other analytical techniques or experimental data. This can help in ensuring the accuracy and reliability of the findings.

By following these steps and using proper methodology and digital tools, researchers can effectively analyze surface images of substrates and determine their relative values for various relative applications based on the literature [28, 29, 30].

The selection of nontoxic stabilizer and selection of an appropriate reducing agent for the stability of Ag-nanoparticles is a crucial problem because shape, size, and size distribution strongly depend on the nature of reducing and stabilizers [13]. Metal nanoparticles those were prepared by the mild reducing agents, was relatively more stable compared with those produced by excess of strong reducing agents [14].

4. CONCLUSIONS

The paper presents a method for obtained by chemical reduction some silver nanoparticles of various concentrations varying in the range 5 and 100 ppm.

Based on the analysis of AFM images could be determined film thickness and thin colloid roughness ; the values obtained were between 128 and 63 nm.

Absorption spectra were plotted for all samples in the spectral range 300-1100 nm. The obtained silver nanoparticles can be used successfully in different applications.

Moreover, analyzing in detail the colored values obtained for both thickness and the roughness is advantage of obtaining layers films. Proper preparation in chemicals, instruments, preparation of Ag-nanoparticles as well as proper digital technologies, digital image processing tools should be used so as to obtain useful analyses in relative sustainable solutions for stakeholders.

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