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Investigation of Physical Properties of Silver Nanoparticles Grown on Glass Substrate using Physical Vapor Deposition

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Abstract

Silver nanoparticles (AgNPs) have a wide variety of applications and they are fabricated by using various physical deposition methods. Recent studies indicate the lack of properties and characteristics of physically synthesized AgNPs. In this study, AgNPs were grown on glass substrates (soda lime) by employing a solid-state physical vapor deposition method using thermal evaporation of 95.8% pure silver. 20 and 40 nm thin silver films were deposited on the glass substrates. Individual samples were annealed at a temperature of 200℃, 250 ℃, 300 ℃, 350 ℃ and 400℃ for a constant time duration. Thermal treatment promoted the morphological modification of the films, leading to the formation of AgNPs. After an inspection for film quality with an optical microscope, the 20 nm samples annealed at 250 ℃ to 400 ℃ and the 40 nm samples annealed at 300 ℃ and 400 ℃ were selected to use with the Scanning Electron Microscope (SEM) imaging process. A clear growth of AgNPs was not initiated according to SEM images of 20 nm samples, but for 40 nm samples, the growth was promoted and well observed. An analysis of the morphological and surface characteristics of AgNPs was carried out using the ImageJ software. The ImageJ's particle analysis results of SEM images indicated that the average particle size of the 40 nm layer was 27 nm with an annealing temperature of 300 ^{0}C. But for 400 ^{0}C annealed temperature it was 104 nm with the same layer thickness. Analysis of SEM results also interpreted that the average circularity of the particles also increased from 0.793 to 0.873 with the promotion of annealing temperature from 300 ℃ to 400 ℃. Our results confirm that a higher annealing temperature produces larger nanoparticles as a result of the higher surface diffusion as observed in Barman et al. 2018.

Keywords*: SEM, Silver Nanoparticles, Surface Diffusion, Thermal Evaporation.*

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