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Facile Synthesis and Characterization of Heterostructure Core-Shell Silver-Silica Nanocomposite for Humidity Sensing

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Abstract : Silver (Ag) and silica (SiO2) nanoparticles were synthesized using the chemical reduction method from silver nitrate and sodium silicate, respectively. X-ray Diffraction (XRD), High-Resolution Transmission Electron Microscopy (HRTEM), Scanning Electron Microscopy (SEM), Uv-Visible spectroscopy, Energy Dispersive X-ray (EDX) spectroscopy and N2 adsorption-desorption techniques were utilized to characterize the composition and structure of the samples. The crystallinity pattern of Ag nanoparticles was indexed as (111), (200), (220) and (311), which allowed reflections from face-centered cubic silver. XRD of SiO2 showed good porosity with a broad-spectrum band at Bragg's angle 2θ of 22° while that of Ag-SiO2 showed distinct peaks at 2θ values of 39°, 43°, 66° and 79°. The XRD result agreed perfectly with the SEM and HRTEM images which showed Ag-SiO2 isotropic and anisotropic under the varying concentration of reactants. The elemental composition of Ag-SiO2, as displayed by EDX, confirmed Ag enrichment in the Ag-SiO2 heterostructure. The Uv-Visible peak at 421 nm confirmed the Surface Plasmon Resonance absorption peak of silver nanoparticles. N2 adsorption-desorption result showed a broad band of Ag-SiO2 from 3 to 8 nm, which indicated relatively narrow pore size distributions. Humidity sensing measurements performed in a controlled humidity chamber showed very high sensitivity with a sensitivity factor (SF) of 4.63 and high linearity with a steady decrease in resistance to humidity from 880 Ω at 10% RH to 190 Ω at 100% RH, indicating that Ag-SiO2 nanocomposite is a good sensing material with high sensitivity and linearity.

Keywords : silver, silica, nanocomposite, synthesis, heterostructure, core shell
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