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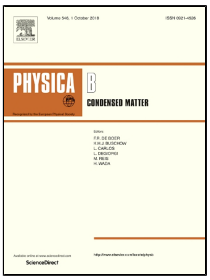

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Synthesis and characterization of Cu-C_{60} plasmonic nanocomposite

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Abstract

Plasmonic nanocomposite thin film containing Cu metal nanoparticles in fullerene C_{60} matrix is developed by thermal co-evaporation method on glass substrate. In order to excite the surface plasmon resonance (SPR), thermal annealing is performed from 100 °C to 400 °C on as-deposited thin film in an inert atmosphere (continuous flow of Ar gas) for 30 minutes. SPR is successfully generated at ~ 694 nm for the film annealed at a temperature of 300 °C which is further blue shifted at ~ 684 nm at a temperature of 400 °C. The film thickness and Cu metal atomic concentration is found to be ~ 70 nm and ~ 27 at.%, respectively using Rutherford Backscattering Spectroscopy. Raman spectroscopy is used to identify the structural changes occurring in fullerene C_{60} matrix with thermal annealing. The transformation of fullerene C_{60} into amorphous carbon is observed with increasing temperature. Transmission electron microscopy is used to confirm the growth of Cu nanoparticles with increasing temperature and particle size is found to be 27.9 nm for the film annealed at 400 °C. The modifications in surface morphology of annealed samples are studied by field emission electron microscope (FE-SEM) and atomic force microscope (AFM). The absence of Copper oxide in the annealed samples is confirmed by X-ray photoelectron spectroscopy. Current vs. voltage measurements are performed to quantify the increased conductivity of annealed samples.

Keywords: Plasmonic nanocomposite, fullerene, thermal annealing

Introduction

The demand for plasmonic nanocomposite with improved electronic, conducting and optical properties is at high demand to enhance its applicability. Metal-matrix nanocomposites have been extensively studied by research community due to their interesting properties including optical, electrical, mechanical and structural properties which make them outstanding candidate for various applications such as in solar cells, memory devices, biomedical devices, sensors etc. The essential step to develop a nanocomposite is the selection of filler component in nano-dimension. Metal nanoparticles (NPs) are the most interesting filler components to be used in nanocomposite due to its tremendous properties such as high surface to volume ratio, size effects, catalytical properties etc. Noble metal nanoparticles (Cu, Ag, and Au) show exceptional optical properties in visible region resulting from an interesting phenomenon which involves the oscillations of electronic cloud in presence of electromagnetic radiation known as surface plasmon resonance (SPR). To tune the optical properties namely SPR has been an exciting research topic to be addressed. The interaction that occurs between electromagnetic radiation and electronic cloud present on the surface of the metal nanoparticle basically includes two processes; (i) scattering (ii) strong absorption. These processes are decided by the metal particle dimensions with respect to the incident electromagnetic radiation wavelength. Absorption will be dominated if the size of the particles is small, whereas scattering

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