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Synthesis and Characterization of Au-C₆₀ Nanocomposite

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Abstract

Au-C₆₀ nanocomposite thin film (Au nanoparticles embedded in fullerene C₆₀ matrix) is synthesized by thermal co-evaporation method and subsequent thermal annealing from 150°C to 300°C. A very small concentration of Au (~ 2 at.%) is chosen in order to minimize the deterioration of the physical and chemical properties of fullerene C₆₀ due to the presence of metal. Spherical shaped Au nanoparticles with a diameter of 2.1 ± 0.04 nm are clearly seen in the TEM images of the nanocomposite annealed at 200°C. A broad surface plasmon resonance peak at ~ 581 nm emerges in UV-visible absorption spectrum due to the evolution of Au nanoparticles at a temperature of 250°C, which is further blue shifted at ~ 554 nm with a narrower FWHM at 300°C. The presence of Au nanoparticles is also confirmed by X-ray diffraction with Au (111) and Au (200) fcc reflections. Thermally induced transformations of fullerene C₆₀ matrix at high temperatures is studied by Raman spectroscopy on pure fullerene C₆₀ films (without metal). The blue shift of LSPR at a temperature of 300°C is ascribed to the transformation of fullerene C₆₀ matrix into amorphous carbon and is explained in terms of Mie theory. TEM results show the growth of Au nanoparticles in fullerene matrix at higher temperatures due to the enhanced diffusion of Au atoms and Ostwald ripening.

Keywords: LSPR, nanoparticles, fullerene, optical properties

1. Introduction

Fullerene is a well recognized material and a key topic for scientific community that is being used for tremendous applications in different fields such as in biomedical, optical devices, hydrogen storage, energy conserving devices etc due to its various attractive properties of high electron affinity, unique molecular size, high reactivity, optical limiting and biological activity [1-4]. Several groups are working on this material to exploit it for diverse applications. In order

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