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Generation of ZnO-Au Nanocomposite in Water Using Pulsed Laser Irradiation

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Abstract : Generation of ZnO-Au nanocomposite under laser irradiation of a mixture of the ZnO and Au colloidal suspensions are experimentally investigated. In this work, firstly ZnO and Au nanoparticles are prepared by pulsed laser ablation of the corresponding metals in water using the 1064 nm wavelength of Nd:YAG laser. In a second step, the produced ZnO and Au colloidal suspensions were mixed in different volumetric ratio and irradiated using the second harmonic of a Nd:YAG laser operating at 532 nm wavelength. The changes in the size of the nanostructure and optical properties of the ZnO-Au nanocomposite are studied as a function of the volumetric ratio of ZnO and Au colloidal suspensions. The crystalline structure of the ZnO-Au nanocomposites was analyzed by X-ray diffraction (XRD). The optical properties of the samples were examined at room temperature by a UV-Vis-NIR absorption spectrophotometer. Transmission electron microscopy (TEM) was done by placing a drop of the concentrated suspension on a carbon-coated copper grid. To further confirm the morphology of ZnO-Au nanocomposites, we performed Scanning electron microscopy (SEM) analysis. Room temperature photoluminescence (PL) of the ZnO-Au nanocomposites was measured to characterize the luminescence properties of the ZnO-Au nanocomposites. The ZnO-Au nanocomposites were characterized by Fourier transform infrared (FTIR) spectroscopy. The X-ray diffraction pattern shows that the ZnO-Au nanocomposites had the polycrystalline structure of Au. The behavior observed by images of transmission electron microscope reveals that soldering of Au and ZnO nanoparticles include their adhesion. The plasmon peak in ZnO-Au nanocomposites was red-shifted and broadened in comparison with pure Au nanoparticles. By using the Tauc's equation, the band gap energy for ZnO-Au nanocomposites is calculated to be 3.15–3.27 eV. In this work, the formation of ZnO-Au nanocomposites shifts the FTIR peak of metal oxide bands to higher wavenumbers. PL spectra of the ZnO-Au nanocomposites show that several weak peaks in the ultraviolet region and several relatively strong peaks in the visible region. SEM image indicates that the morphology of ZnO-Au nanocomposites produced in water was spherical. The TEM images of ZnO-Au nanocomposites demonstrate that with increasing the volumetric ratio of Au colloidal suspension the adhesion increased. According to the size distribution graphs of ZnO-Au nanocomposites with increasing the volumetric ratio of Au colloidal suspension the amount of ZnO-Au nanocomposites with the smaller size is further.

Keywords : Au nanoparticles, pulsed laser ablation, ZnO-Au nanocomposites, ZnO nanoparticles
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