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›tical analysis of Ni^c-Ag^s based nanocomposite films for promising ›plication as ultraviolet region bandpass filters

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ABSTRACT

In the present work, structural and optical analysis of polyvinyl alcohol (PVA) embedded with bimetallic nickel (Ni)-silver (Ag) core–shell architecture nanoparticles (CSANPs) have been presented. Appearance of surface plasmon resonance (SPR) band at 419 nm in optical absorption spectra confirms the formation of nanometric Ag shell over Ni core. Optical spectroscopy data is further analyzed to compute distinct optical parameters. Optical energy gap (E_{opt}) for PVA decreases from 4.21 ± 0.06 eV to 3.20 ± 0.04 eV and urbach's energy (E_U) increases from 0.60 ± 0.09 eV to 1.08 ± 0.07 eV for nanocomposite incorporated with 0.4 wt% amount of CSANPs. Transmission spectra depicts that UV region exhibit a narrow band centered at a wavelength ~320 nm for CSANPs embedded in PVA and is of potential interest as band pass filter.

1. Introduction

Bimetallic core shell nanoparticles (NPs) are receiving significant attention of scientific community around the world owing to their competence to integrate the peculiar attributes of two distinct entities into a single nanostructure [1]. In general, among various transition metal NPs, noble and ferromagnetic metal NPs are subject of interest for synthesis of bimetallic CSANPs due to their unique magnetic, biological, electronic and catalytic properties [2] and these qualitative attributes enhances their applications in multidisciplinary areas such as biomedi-›ine, heterogeneous catalysis, optoelectronics and microelectronic [3–6]. Particularly, Nickel (Ni), among various ferromagnetic NPs have numerous interesting and commendable characteristics such as relatively low cost, high electrical conductivity, suitable melting point along with applications in diverse areas [7]. Liu et al. [8] have studied the importance of Ni $(OH)_2$ NPs as application in rechargeable battery system and have seen the effect of geometry and concentration of NPs on the performance of these systems. Addato et al. [9] fabricated Ni @ NiO NPs in core–shell morphology and studied their applications in enhanced magnetic resonance imaging. Inspite of all motivating and unique attributes of Ni NPs, their rapidly oxidizing nature in atmospheric environment and toxicity to bio-molecules or cells limits their use in practical applications [6]. Thus, encapsulation of these NPs in suitable material productively slows down the infiltration of oxygen to the surface of Ni NPs and enhances its stability and functionality as well [10,11]. Among distinct noble metal NPs, Silver (Ag) NPs have significant importance due to their remarkable optical, antimicrobial and antibacterial characteristics along with anti-oxidant, anti-resistant and chemically suitable nature make them a strong contender for shell layer material over Ni core [12]. Moreover, appearance of SPR peak associated with Ag NPs in visible region due to absorption of electromagnetic (e.m.) radiations gives them an edge over other metals for applications in advanced technological fields like nano-photonics, nano-biotechnology and nano-plasmonic [13]. SPR occurs due to the collective oscillations of the conduction electrons [14–16]. The intensity and wavelength of SPR peak is strongly governed by geometry, size, composition and distribution of NPs as well as by surrounding medium as these parameters can tailor the chemico-physical properties of noble metal NPs [17]. Thus, blending of two distinct metallic entities into a unique architecture (core–shell architecture) not only prevents Ni NPs from oxidation but also enhances properties and application domain of core shell NPs. Swierzy et al. [7] have studied the conducting properties of Ni–Ag core–shell NPs and observed the effect of various conditions like temperature, sintering time etc. on conductivity of NPs. Chen et al. [18] have synthesized protective agent free Ni–Ag core–shell NPs and studied the structural morphology by using TEM and XPS. Lee et al. [19]

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