ABSTRACT

The present research work reports an *in-situ* chemical synthesis of Au-nanoparticles (Au-NPs) of selective shapes and sizes in forms of Au-poly(vinyl alcohol) (PVA) and Au-PVA/sucrose nanofluids, films and recovered Au-NPs from the organic part and their characterization in terms of microstructure, X-ray diffraction (XRD), optical and other properties. A simple $Au^{3+} \rightarrow Au$ reaction of a gold salt, such as $HAuCl_4 \cdot 3H_2O$, occurs with reactive polymer molecules of PVA of refreshed surfaces in an aqueous medium (hot) in steps. It is proposed that the selective Au-NP shapes form in a topotactic growth over thin polymer templates, which serve purposely as a reductant as well as an immobilizer to the Au-NPs. The Au-contents in the nanofluids and films have been varied in steps as 0, 0.05, 0.1, 0.2, 0.5, 1.0, 2.0 and 5.0 wt% in an attempt to develop useful properties for color pigments, optical materials and other applications.

Chapter-1 gives a general introduction about the subject, reviews of the methods for synthesis of Au-NPs and derived nanocomposites, and their typical properties and applications. Chapter-2 describes experimental methods used in this work and the XRD, microstructure, and other analytical methods applied in part of the characterization. The results and analyses are presented with discussion among six chapters. Chapter-3 deals with the mechanism of formation (based on the XRD and microstructures in the nanofluids and films) of shape controlled Au-NPs in support over polymer templates of PVA or PVA/sucrose. The dynamic light scattering and rheological studies of Au-PVA nanofluids by analyzing hydrodynamics of the Au-NPs are discussed in Chapter-4. Thermal stabilities of the Au-PVA nanocomposites are described with TG-DTA thermal studies in Chapter-5. The electronic structure of the nanocomposites is studied in terms of the characteristic XPS bands of Au-NPs and those of the carbon and oxygen from PVA molecules in the matrix or in the Au-PVA surface interfaces. It has been analyzed that, during the primary $Au^{3+} \rightarrow Au$ reaction with refreshed reactive PVA molecules, part of the PVA molecules is coating the resulting Au-NPs in a kind of a core shell structure. This is described in correlation to the dielectric/electrical properties of the Au-PVA nanocomposite films in this chapter.

Chapter-6 describes the results and discussion of optical absorption and emission in the Au-PVA, Au-PVA/sucrose nanofluids and films. Modification of the Au-SPR band upon the presence of the sucrose signifies its role as an additive in controlling the final Au-NP size and shape in the Au-PVA/sucrose nanofluids. However, use of sucrose is not a good option to obtain high quality of optical films with reasonably smooth surfaces due to its hygroscopic nature. Furthermore, emission spectra in Au-NPs recovered from the polymer films (after burning out the organic part in air) are described in Chapter-7. The recovered Au-NPs are also light-emitting. Blue and yellow emission occurs in two distinct bands at 535 nm and 585 nm, useful for optical displays, optical coating, and other applications. Finally, a summary of the work with salient features achieved in this work is briefed in the last Chapter-8 along with a future scope of the work in this series on Au-NPs and hybrid nanocomposites of core-shell structure.

Keywords: Au-nanoparticles, Nanofluids, Nanocomposites, Microstructure, Optical properties, Dielectrics.