ABSTRACT

The present research work reports synthesis of stable nanofluids and films, which consist of nanostructured gold (n-Au) embedded in a polymer of poly(vinylidene fluoride) (PVF_2), and their characterization in terms of rheology, microstructure, X-ray diffraction (XRD), and optical properties. A simple in-situ $Au^{3+} \rightarrow Au$ reaction is carried out by adding a $HAuCl_4 \bullet 3H_2O$ salt solution in N,N-dimethylformamide (DMF) to a PVF_2 solution drop by drop at 50-60 °C with an ultrasonic irradiation. A reaction sensitizer of triethanolamine (TEA) was added in a small amount of 1 – 2 vol% during the reaction so that it promotes a dynamic $Au^{3+} \rightarrow Au$ reduction reaction, wherein the resulting n-Au is dispersed via the PVF_2, and surface stabilized in the form of a stable nanofluid. The Au-content has been varied both in the nanofluids and films in small steps of 0.1, 0.2, 0.5, 1.0, 2.0, and 5.0 wt% in order to tune the rheology and optical properties suitable for color dyes, biosensors, optical materials, and other applications.

Chapter-1 gives a brief introduction, applications and unique properties of the nanomaterials. It includes an extensive literature survey of the studies reported on the methods for synthesis of Au-PVF_2 nanofluids or composites and their typical properties and applications. A statement of the problem is made according to the work done so far in this descipline along with the motivation behind choosing this research work, and several intriguing properties and applications of such materials. Experimental methods used in part of the characterization with uv-visible absorption spectroscopy, infrared (IR) absorption spectroscopy, light-emission, X-ray diffraction (XRD), and other selective analytical methods are described in Chapter-2. Obtained results are presented in five Chapters. The results of rheology in correlation to absorption in the phonons and electronic bands in bare PVF_2-DMF solutions of varied concentrations of 1, 10, 20, 30, 50, and 100 g/L PVF_2 are presented in Chapter-3. The rheology parameters are shown to obey a Newtonian behavior in these samples. Chapter-4 is planned to describe the effects of n-Au doping on the rheology and electronic absorption/emission bands in the Au-PVF_2 nanofluids in correlation to the phonon bands. It is observed that PVF_2 when reinforced with n-Au reassumes refined surfaces of exfoliated molecules, which sensitively tune the absorption bands in the localized surface plasmons in n-Au over the 500-800 nm region.

Chapter-5 deals with microstructure and phase analysis both in n-Au and the polymer parts in Au-PVF_2 nanofluids and nanocomposite films. The HRTEM images describe an inbuilt inorganic–organic Au-PVF_2 interface which renders an energy transfer in light absorption and emission in a core-shell structure. Chapter-6 describes optical, thermal, and dielectric properties for the Au-PVF_2 nanocomposite films. Different shaped n-Au support thermal stability of a hybrid Au-PVF_2 composite against degradation in open air. Finally, a summary of the work with salient features achieved in this work is described in the last Chapter-7 along with a future scope of the work in this series on Au-PVF_2 nanofluids and films.

Keywords: Nanofluids; Nanocomposite films; Poly(vinylidene fluoride); Optical properties