Gold nanoparticles stimulated surface plasmon resonance effects in erbium-zinc-sodium-tellurite glass

Abstract

Modifying the optical characteristics of rare earth (RE) doped inorganic glasses by stimulating surface plasmon resonance (SPR) via controlled growth of metal nanoparticles (NPs) is an outstanding quest in glass plasmonics. Glasses with composition $70TeO_2$-$20ZnO$-$10Na_2O$-(x)Er_2O_3-(y)Au (x = 0.0 and 1.0 mol%; y = 0.0 and 0.6 mol% both in excess) are synthesized using melt-quenching technique and characterized. Influences of heat treatment temperature on the growth of Au NPs and their subsequent impacts on Raman spectral features modifications are inspected. The amorphous nature of glass is confirmed by using XRD. TEM reveal the non-spherical Au NPs with average diameter vary from 7.4 to 10.3 nm. Surface plasmon band is evidenced around 627 - 632 nm. Raman spectra demonstrate the presence of Er-O and Zn-O bond, anti-symmetric vibrations of Te-O-Te bonds and stretching modes of non-bonded oxygen exists in TeO_3 and TeO_{3+1} unit. The amplifications in Raman signals by a factor of 1.39, 1.40, 0.88 and 1.29 and 1.25 corresponding to the peak centered at 262, 382, 536, 670 and 725 cm^{-1} are attributed to the contribution of a surface plasmon (SP) generating a strong, localized and secondary field. The excellent features of the results suggest that our systematic method of controlled NPs growth may constitute a basis for improving the spectral features of tellurite glasses useful for the development of efficient and economic up-converted lasers.