

Raman Scattering Study of PEDOT: PSS/Ge Composite films

Sharad Tripathi

Department of Physics, Guru Nanak Khalsa College of Arts, Science & Commerce (Autonomous),
Matunga, Mumbai, India.

DOI: <https://doi.org/10.51584/IJRIAS.2026.11090068>

Received: 23 September 2026; Accepted: 28 September 2026; Published: 12 October 2026

ABSTRACT

Cleaned surface of spin coated of PEDOT: PSS on quartz glass was deposited by thin films of Germanium (Ge) on it using vacuum deposition technique. Thin films of Germanium (Ge) of thickness 50 nm, 75 nm and 100 nm were deposited by electron beam gun evaporation system. The prepared composite thin films were characterized for its surface and structural properties by using Raman scattering spectroscopy. Clusters of different sizes with surface roughness are seen due to deposition of Ge thin film layers and also showed multiple peaks and amorphous nature inside the materials in form of clusters. Different Grain size of clusters is also found non-uniform in all deposited films.

Keywords: Germanium (Ge), Thin Films, Raman spectroscopy.

INTRODUCTION

Synthesis of small sizes of particles on the surface and embedded in the matrix of samples by doping method thermal and ion beam irradiation is a promising method as reported in the literature [1]. The formation of spherical and uniform Pt nanoparticles on SiO₂ surface has been reported as a result of thin Pt film [2]. Metal oxide nanoparticles thin films are generating increasing interest due to their potential applications in household electronics, recording heads, memory and day to day life being used devices [3]. The addition of inorganic nanoparticles to polymers allows the modification of the polymer physical properties as well as the implementation of new features in the polymer matrix [4]. With decreasing particle size, the ratio of surface/volume increases, so that surface properties become crucial. Smaller the particles are, more important will be the surface properties, thereby influencing interfacial properties [5].

However, a very limited data is available for the modification of optical and structural properties by thin film deposition method. The structural means formation of clusters inside material, tuning of optical energy band gap and crystalline size of all samples can be controlled by electron beam gun deposition by controlling various parameters (current, power, thickness, temperature etc.).

The main objective of this work was to study the optical and structural properties of the thin films (Germanium (Ge) deposited) using vacuum deposition technique.

Experimental Details

Spin coating is a fast and easy method to generate thin and homogeneous organic films out of solutions. Spin coating is a procedure used to apply uniform thin films to flat substrates. In short, an excess amount of a solution is placed on the substrate, which is then rotated at high speed in order to spread the fluid by centrifugal force. A machine used for spin coating is called a spin coater. The samples for the present work were prepared in the size of dimensions: 15 mm x 15 mm. Slides were first cleaned in de-ionized (DI) water and acetone to remove the impurities from the surface of the slides. All the cleaned samples were deposited of germanium thin films for thickness 50 nm, 75 nm and 100 nm using Electron Gun Beam Evaporation Methodology at Department of Physics, University of Mumbai at room temperature. After deposition, the samples were cleaned in safer mode. The samples were dried and stored in desiccators for characterization.

The Raman spectra of the all samples were recorded in the transmittance mode using the Raman spectrometer in department of Physics, University of Mumbai.

RESULTS AND DISCUSSION

Raman scattering spectra were recorded using RENISHAW in via Raman Microscope at room temperature using 4W argon ion laser of wavelength 514 nm. Raman Spectra of germanium thin films for thickness 50 nm, 75 nm and 100 nm are shown in figure-1. It can be seen that the peak located at 278 cm^{-1} , which corresponds to transverse optical phonon modes of oscillations (TO) mode of oscillations, is in agreement with the reported literature. The TO peak is broad (FWHM= 70 cm^{-1}) and therefore the film is amorphous in nature. There is an asymmetrical broadening on the lower frequency side when compared with the spectrum of the bulk Ge. The shift of the Raman band in thin films with respect to its value in bulk Ge can arise due to tensile or compressive strain and phonon confinement. Because the film is deposited on polymer, the peak at 1438 cm^{-1} comes from the PEDOT:PSS film.

However, a noticeable change was observed in the intensity of peak of PEDOT:PSS. The peak position remains unaltered but the intensity of peak decreases drastically on increasing the thickness. This can be attributed to the breaking of polymer chain of germanium into the polymer matrix. It can be observed from Table that FWHM of germanium peak at $\sim 278\text{ cm}^{-1}$ decreases indicating increased cluster size due to agglomeration caused by fast deposition Ge thin films, may be due to the diffusion of films among it.

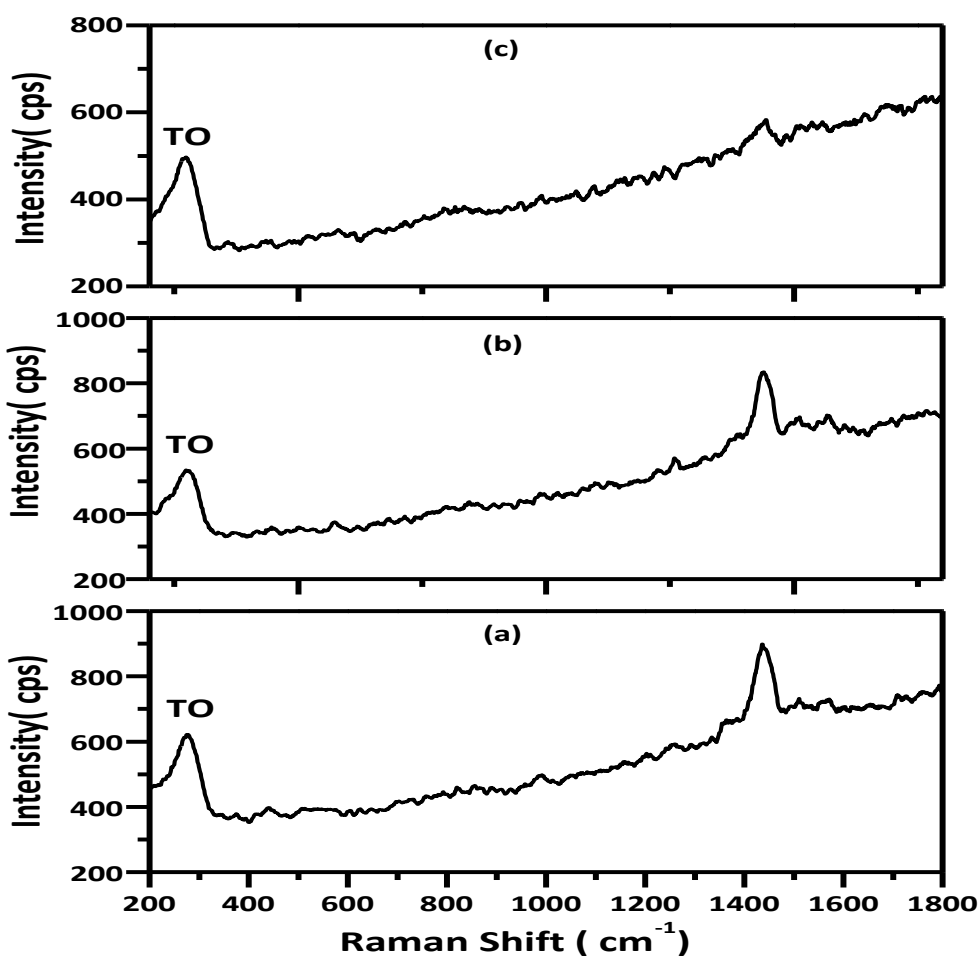


Figure: Raman spectra of PEDOT: PSS/Ge composites films of thickness (a) 50 nm, (b) 75 nm and (c) 100 nm.

Table Parameters calculated from Raman spectra of PEDOT: PSS/Ge composite films of thickness (a) 50 nm, (b) 75 nm and (c) 100 nm.

Samples	Peak Position (cm ⁻¹)	Intensity (CPS)	FWHM (cm ⁻¹)
50 nm	278.34	630	59.23
75 nm	278.34	580	58.00
100 nm	278.34	488	55.00

CONCLUSION

The decrement of FWHM in spectra recorded by Raman spectroscopy was seen in higher values of Ge deposition may be due to atomic mixing inside the materials. Also, may be formation of various sizes of clusters generated in samples after atomic mixing.

REFERENCES

1. Jai Prakash, Tripathi A., Lakshmi G. B. V. S., Rigato V., Tripathi1 Jalaj, Avasthi D. K. Adv. Mat. Lett., 4(6), 408 (2013). Martin N., Serruys Y., Nucl. Inst. And meth. B, 105,175, (1995).
2. Zhou X., Wei Q., Sun K., Wang L., Appl. Phys.lett. , 94,133197, (2009)
3. In-Yup Jeon and Jong-Beom Baek, Materials,3, 3654-3674 (2010).
4. S. S. Shinde, R. A. Bansode, C. H. Bhosle, J. of semiconductors,32 (1),013001-1-8,(2011).
5. Zhanhu et. al., Journal of Nanopart Res12: 2415 - 2426 (2010).