This thesis was dedicated to the investigation of the acoustic phonon quantization of metal and semiconductor nanoparticles (nanostructure). The results represented in this thesis are obtained due to Raman scattering. We have showed that the Si/Ge nanocrystals embedded in glass matrix and free standing metallic silver and gold nanoparticles can be satisfactorily described by Raman scattering in terms of low-frequency Raman scattering (LFRS), structural and optical properties. Detailed inspection on recently discovered properties of LFRS to reflect a crystalline quality of metal nanoparticles and ion implanted Si/Ge semiconductor nanoparticles has demonstrated interesting results. In the case of metal nanoparticles, low frequency and transmission electron micrograph analysis results show that the silver and gold nanoparticles are spherical in shape; this fact allowed us to consider each metal nanoparticle as an isolated homogeneous elastic sphere and use lamb’s theory to observe size dependence of acoustic modes. New findings in the case of silver nanoparticles were observed from the LFRS. The observed low frequency Raman peaks are assigned to the spheriodal mode $l=0$ and $l=2$, and Raman forbidden $l=1$. In addition many low frequency bands were observed along with the characteristic peaks which were assigned to harmonics/overtones due to narrow size distribution and good particle crystallinity. A large discrepancy in the case of the selection rules for low frequency modes for metal nanoparticles leads us to verify and resolve this issue to some extent. The direct observation of acoustic vibrations of silver and gold nanoparticles with wide range of frequencies i.e from 0.45 to 0.97 THz may open up the way to the development of terahertz acoustic resonators.

The implantation of Si and Ge ions at 1100°C leads to the formation of nanocrystals of two sizes in same sample which after annealing for about 30 minutes transforms to single sized nanoparticles. We have interpreted the LFRS for
semiconductor nanoparticles embedded in different matrixes; the presence of matrix dramatically influences the Raman profiles of the spectra, which is very well explained. It is observed that the phonon line width increases in the case of elastically similar materials due to matching of acoustic wave reflection. Electron phonon coupling/interaction was calculated from the ratios of intensities, it is found to be higher in elastically dissimilar materials. In the case of exposure dependent optical Raman spectra for Si nanocrystals in SiO\textsubscript{2} matrix led to new mode in LFRS attributed to first order activated transverse acoustical scattering arising from the breakdown/relaxation in wave vector selection. A similar kind of observation was obtained for titanium dioxide nanocrystals from the low frequency Raman scattering.

The results obtained by the first principles calculations based on density functional theory (DFT) give an information about the electronic properties and vibrational density of states of ZnO nanowires and metallic silver clusters which is very much needed in modern science. In order to understand the vibrational dynamics of these poorly known, in terms of DFT calculation, we investigated the electronic and vibrational properties of ZnO nanowires and silver clusters of different sizes along with their bulk counterparts. The band gap increases as the diameter of the wire decreases. Making comparison of the nanostructures itself and with bulk, we find two different features in the case of electronic DOS of metallic silver cluster. There is removal of degeneracy of many phonon modes along with the appearance of several new phonon modes in the case of ZnO NW. The specific heat decreases in the case of ZnO NW. The vibrational DOS turns to the descritization (quantum confinement) along with the significant changes in the low frequency region. In the case of ZnO NW there is a formation of asymmetric tail. The vibrational DOS in the case of Ag clusters show descritization in addition to the significant changes in the profile and position of
peaks in VDOS particularly in the low frequency region. This can be directly linked to the specific heat and thermal conductivity of silver nano clusters.

**Future Direction**

The knowledge and experience during this work will be fruitful in the investigation of the vibrational dynamics of more complex systems such as nanostructures and hybrid nanostructures. Further, it inspires material scientist to explore new ways of analyzing the vibrational dynamics of low dimensional structures. In addition the work on nanofluidics carried out in this thesis will be helpful in the future to synthesize and characterize the nanofluidics.
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Education  
2009  
M.Sc., Bhavnagar University  
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2004  
H.S.C., Gujarat State Education Board  
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Skills  
Programming Languages  
C and FORTRAN  
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DOS, Windows 98/2007/XP, Linux  
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Achievements and Awards  
2012-till  
SRF awarded under Council for Scientific  
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2010-2011  
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Curriculum Vitae and List of Publications

2009-2010
Project Fellow in UGC, New Delhi project entitled at, Department of Physics, Bhavnagar University.

2010
Awarded Gold Medal, for securing highest marks in M. Sc. (Physics), Dept. Of Physics, Bhavnagar University.

2007
Won the First Prize in Poster Presentation held at CSMCRI, Bhavnagar on the occasion of the celebration of International Physics Year 2006-07.

Professional Memberships
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Conferences/ Seminar attended

2012
Seminar on Recent Advances in Applied Optics and Optoelectronics, at M.S. University, Baroda.

2012
23rd International Conference on Raman Spectroscopy, Bangalore, India – ICORS.

2012
3rd National Conference on Condensed Matter and Materials Physics, Sardar Patel University, Vallabh Vidyanagar, Gujarat.

2011
International Conference on High Pressure Science and Technology, Bhabha Atomic Research Centre, Mumbai, India.

2011
National Conference on Computational Techniques in Physics, The M.S. University of Baroda, Vadodara.

2010
3rd DAE-BRNS International Symposium on Materials Chemistry (ISM C), B.A.R.C., Trombay, Mumbai.

2010
International School and Conference on Nucleation Aggregation and Growth, JNCASR, Bengalur .

2010
One Day workshop on “A Nano-Material Research Awareness Programme” Department of Physics Bhavnagar University, Bhavnagar.

2009
XIV Workshop on Neutrons as Probes of Condensed Matter, BARC, Mumbai.

2009
International conference on Neutron Scattering and Mesoscopic Systems, CNSMS -09, Goa.
2009  National Symposium on DAE-SSPS, M. S. University of Baroda, Vadodara, India.
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**Book Chapter**


**Publications**


