

## Characterization of Optical Response of Dielectric Nano Antennas Having Complex Structures

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<b>ABSTRACT</b>	Characterized optical response of dielectric antennas have been complex structures have been studied. Electric and magnetic behavior of electromagnetic modes have been used with dielectric antennas. A quantum mechanical explanation due to inelastic interaction for electron beam was utilized. The calculation for integration for electron beams for orbital angular momentum was made. We have studied dimer of dielectric antennas of cylindrical and circular structures. The excitation components of vortex beam variation was found. For the purpose of study the spherical particles and cylindrical wires were considered of different materials. Electron energy loss spectra based on symmetry was used for the study. The magnetic properties were found due to variation of electron velocity. The characteristics of chirality was also found in the nanostructure of silicon. For controlling the light, the resonant electromagnetic modes of nanoparticles were used having greater refractive index. It was found that characterization of properties were due to resonant modes. The magnetic transition was found in bulk materials.
<b>KEYWORDS</b>	Optical response, dielectric antenna, electromagnetic mode, excitation, vortex beam, chirality.

Received on 27.09.2025, Revised on 24.10.2025, Accepted on 30.11.2025

**How to cite this article:** Kumar N. and Yadav G. Characterization of Optical Response of Dielectric Nano Antennas Having Complex Structures. *Bulletin of Pure and Applied Sciences- Physics*, 2025;44D (2):85-88.

### INTRODUCTION

Karsnok et al. studied high index dielectric nanoparticles of optical nonlinearity. It was proposed a highly tunable dielectric nanoantenna having chain of silicon particles excited by a dipole emitter. Nanoantenna

produced slow group velocity guided modes in infinite structure. It was sensitive for nanoparticles permittivity and tuned through electron hole plasma [1]. Jahani and Jacob presented that dielectric nanoparticles and nanostructures contained positive permittivity for use of nanophotonics and also enhanced

spontaneous emission [2]. Makalov et al. studied high index dielectric nanostructures for nonlinear nanophotonics, showed strong nonlinear response. This was predicted in single silicon nanoparticles and silicon nanodimers and it was modified for radiation properties. Generation of electron hole plasma in germanium nanoantennas turned into plasmonic in mid infrared region [3]. Krasnok et al. studied that substrate affected the nanoantenna characteristics for realizations of nanoantennas. The analysis of  $\text{SiO}_2$  substrate showed that it affected the nanoantennas characteristics. Simulation of nanoantenna having light nanoparticles situated on the  $\text{SiO}_2$  substrate was made and were utilized in commercial software CST microwave studio [4]. Arslanagic et al. presented a cylindrical nanoantenna having multilayer cylindrical metamaterial structure, which produced scattering for the dipole and higher order modes. Five layer system was optimized to show directivity bound [5]. Agio and Alu developed optical nanoantennas to control light matter interactions. Its ability of controlling passive and active nano systems were used in science and engineering [6]. Salary et al. studied the radiation characteristics of individual nanoantennas and modal properties of nanoantenna arrays by the use of charge transport and electromagnetic model. Study of realistic time modulated structures for optical and modulation frequencies were made. Electrical beam scanning functionality and dependence of antenna characteristics for modulation were studied and presented. It was found that optical antenna system was able for full-duplex communication and real time beam scanning and it was useful for optical network [7]. Huang et al. studied the power transfer from one transmitter to different receivers by adjusting the wave front of the optical field incident on the transmitter direction control of the transmitted radiation over a broad range. Applications of optical on chip circuitry, having nanoscale footprints to combine photonics with integrated electronics for high speed computing and high band width communications [8]. Manjavacas presented a model for the study of ability to design optical devices for the control of light at the nanometer scale and found spectral singularities in active hybrid metamaterials [9].

Lu et al. studied transition of electrons for different frequencies transient optical responses. It was found that this was utilized for controlling of phase entanglement of laser dressed electronic states and for increasing electro optical performance in optoelectronic devices [10]. Iurov et al. used Maxwell equations for the study of electric field of transverse longitudinal optical polarization fields. It was found that field electron interaction had higher order harmonics of the total electric field [11]. Kuznetsov et al. studied high index dielectric nanostructures for various optical effects by increasing interaction between the strong field of light and nanostructures were described as versatile semiconductors for nanophotonics devices such as optical nanoantennas and for directional scattering [12].

## METHOD

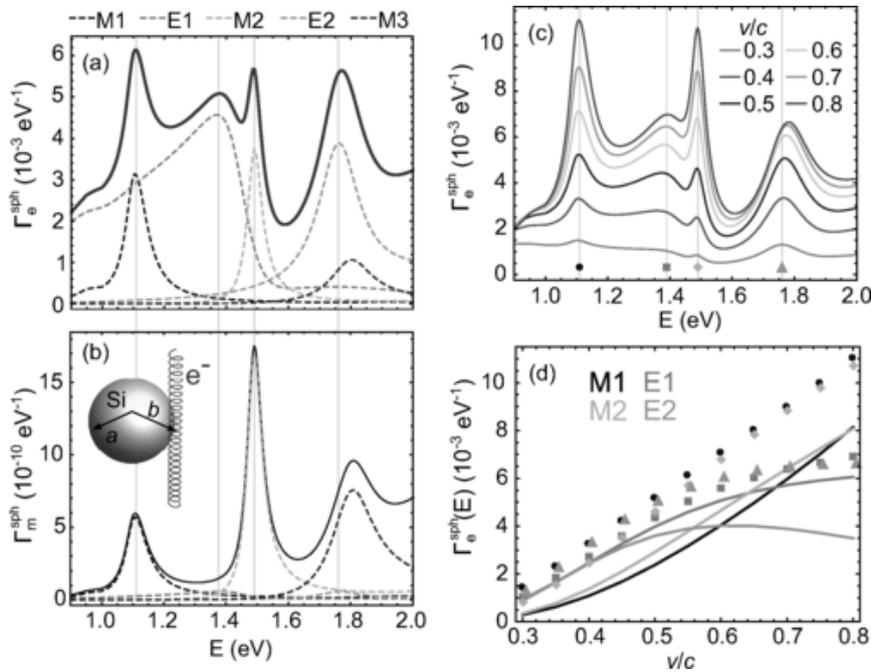
Vortex beam method was used for the study of behavior of electromagnetic modes due to dielectric antennas. The quantum mechanical explanation of inelastic interaction for vortex electron beams was made. The calculation of electron energy loss spectrum considering vortex electron beam for nanostructure of antennas were made. For the purpose classical electro-dynamics was used. The relativistic function was explained due to interaction with the structure were obtained. Loss for vortex electron beam was calculated. Evaluation for a beam carrying orbital angular momentum was made, which yielded individual contributions for different vectors azimuthal component. Vortex electron beam was made possible for loss possibility for vortex electron beam was studied. For this study the theory for canonical system of a single spherical nano particle was used.

## RESULTS AND DISCUSSION

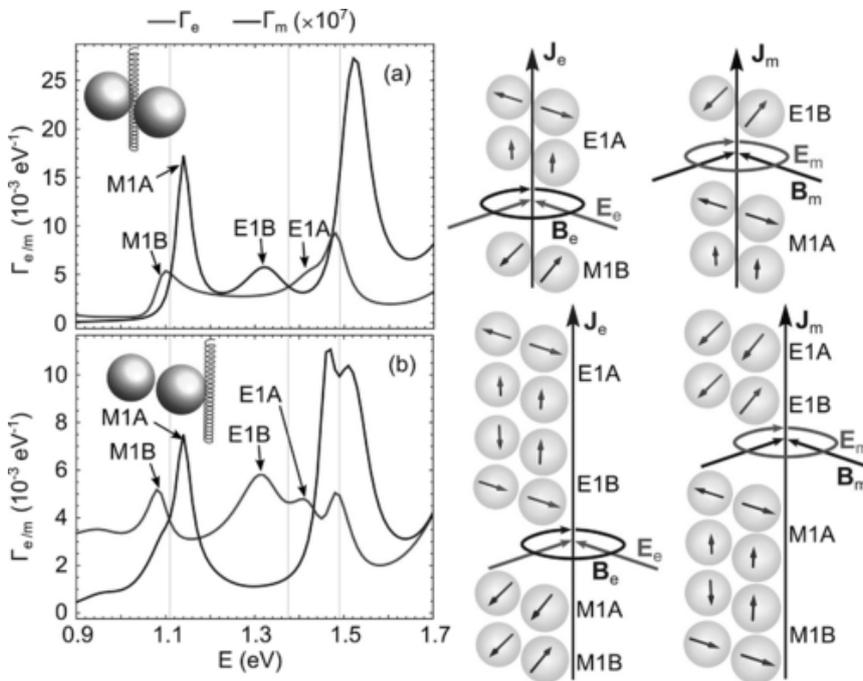
It was calculated numerically electron energy loss probabilities for different samples of different geometries. Graph (1) shows the plot of spectral contribution versus nano-sphere radius. The spectrum shown in graph (1) (a) does not depend on orbital angular momentum for a vortex. Current produced small contribution intensities as shown in peaks of graphs corresponding of electrons. It was found that

dimer is away from each other as small gap, which is shown in Graph (2). Graph (2) also shows the vortex electron energy loss spectroscopy. They are separate from each other. Graph (2) (a) and (2) (b) shows the hybridized

modes contribution to spectra of different vortex electron beam positions. Graph (2) (b) also shows that due to beam movements along the side of sphere along the dimer, then bonding and antibonding of dipolar modes are found.



Graph 1: Plot of spectral contribution vs nanosphere radius.



Graph 2: Plot of electron energy loss vs electron beam length.

## CONCLUSION

Response of dielectric nanoantennas having complex structures were made. It was found that complex dielectric produced induced optical near fields due to vortex. The induced magnetic field was produced near fields of light. The quantum mechanical scattering was used to characterization of optical response of dielectric antennas having vortex. The calculation was made considering vortex electron beams. For this purpose classical electrodynamics was used. The study of dimer and single dielectric antennas of different geometries were used. The case of cylindrical and spherical structures were used for the study. It was found that during interaction for electrons vortex was developed.

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