All Dielectric Optical Nanoantenna

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Submitted By

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(2k15/MOC/16)

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DECLARATION

I Richa Mantri, hereby declare that the work entitled **"All Dielectric Optical Nanoantenna"** has been carried out by me under the guidance of Dr. Ajeet Kumar, in Delhi Technological University, New Delhi.

This project is a part of the degree of Masters in Technology in Microwave & Optical Communication. This is an original work and all sources; reference and literature used and excerpted during elaboration of this work are properly cited and listed in complete reference to the due source.

Richa Mantri
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CERTIFICATE

This is to certify that the dissertation entitled: **All Dielectric Optical Nanoantenna** in the partial fulfilment of the requirements for the reward of the degree of Masters of Technology, Delhi Technological University (Formerly Delhi College of Engineering, University of Delhi), is an authentic record of the candidate's own work carried out by her under my guidance. The information and data enclosed in this project is original.

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ABSTRACT

Optical Nanoantennas for visible and infrared radiation can strongly enhance the interaction of light with nanoscale matter by their ability to efficiently link propagating and spatially localized optical fields. This ability unlocks an enormous potential for applications ranging from nanoscale optical microscopy and spectroscopy over solar energy conversion, integrated optical nanocircuitry, opto-electronics and density-of-states engineering to ultra-sensing as well as enhancement of optical nonlinearities. Thus, the useful results prompt us to implement a more systematic and further exploration on nanoantennas of some specific configurations of interest. This dissertation is the study of various works in the field of optical nanoantenna, thereafter design and analyse optical nanoantenna.

The focus of this thesis is put on the investigations of single and multiple dielectric nanoparticles for their near-field optical and far-field radiation properties. In particular, we elaborately design and carefully analyse such structures to perform their functions as the nanoantennas operating in the optical range. Nanoantennas have been found capable of producing strong enhanced and highly localized light fields. The Generalized Kerker's conditions are studied in detail to understand scattering of light by nanoparticles of various shapes and size. Concept of Fano Resonance which has been well explored and implemented in metallic nanoantenna and only recently being extensively studies and implemented in dielectric materials is studied. In the present work, both the theories for directional scattering by dielectric nanoparticle have been exploited.

A study on the accurate behavior of single dielectric nanoparticle is done as to how the scattering of incident field by the nanoparticle enables it to exhibit unidirectional scattering at wavelengths where the First and Second Generalised Kerker's Conditions are fulfilled. Fano resonance is seen when multiple dielectric nanoparticles are used. In the work for this dissertation linear quadrumer is considered for designing an optical nanoantenna based on directional scattering at the Fano resonant wavelength.

An appropriate numerical approach with use of FEM is developed for a more effective calculation of nanoantennas covering the broad frequency range including visible and infrared region. Comprehensive investigations are carried out and presented in detail on various factors which have significant impacts on the nanoantenna's performance in the optical range. The software used is COMSOL MULTIPHYSICS whose operation is dependent on the finite element analysis method. The software calculates scattering cross section, far-field pattern, and directivity for the optical nanoantenna MATLAB is also used for mathematical computation as and when required.

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