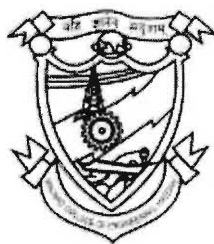


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Optimal Design and Characterization of Optical Antennas for Spectroscopy

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Abstract

Antennas act as transducers or transition device between a guided wave and a free space wave and vice versa. The characteristic dimensions of a typical antenna will be in the order of wavelength of the propagating radiation. While Antennas are the key enabling units for devices like cellular phones and televisions using electromagnetic radiation in the radio wave or microwave regime, their optical version is basically non-existent. Controlling of light is usually accomplished by redirecting its wave fronts by means of diffractive elements. Recent research in the fields of Plasmonics and Nano-optics has generated a wide interest in the concept of “Optical Antennas”. The main purpose of Optical Antennas is to act as a transducer between localized light energy and free radiation energy. Because of reciprocity, optical Antennas increase not only the efficiency of light absorption but also the efficiency of light emission. In this work, we have designed Optimal Optical Nano antenna for spectroscopy application using FDTD software package.

A prototype antenna with spherical and cylindrical geometries is studied. The substrate under study is Silicon, since we are trying to optimize for Spectroscopy. The antenna has been placed at 100nm above the substrate and has been excited by Gaussian source of 550THz placed at 2500nm away from substrate laterally. A silicon waveguide with antenna at one terminating end is used to carry the light energy from the source till the substrate. Electric field distributions, Power distribution, T parameters and Power absorbed are studied for all the geometries mentioned above. Surface corrugations are also introduced into the geometry of the antenna so as to study the effects of enhancements due to irregularities. The results are compared against each other to find out the optimal design of the antenna for Spectroscopy application. Surprisingly, introduction of the irregularities has hampered the localization of the field, which is contradictory for the very statement of Surface Enhanced Raman Scattering (SERS), which is due to the fact that the plane of observation is quite far from the substrate. The results show that cylindrical antenna geometry spanning 50nm base radius and 100nm height shows the best response for the above mentioned scenario.