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Metal Dielectric Plasmo –Optical Data Storage

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Abstract :
In this paper an optical data storage at the metal dielectric interface by exploiting Surface Plasmons has been demonstrated . the design includes 3 layered structure comprising of sio2 as a substrate followed by Si layer as data layer instead of adopting meta material , Al layer with nano apertures filled and coated with SiO2(dielectric layer). When the metal layer is illuminated by the light source the cavities exhibits distinct behaviour. Simulations are done using FDTD algorithm.Al layer with and without cavity /pit have been simulated. Metal layer with pit of volume 0.25nm^3 showed distinct wavelength shift at 1.5761µm.

Keywords: Optical data storage, surface plasmons, FDTD, meta material.

Introduction

Efficient and reliable data storage is the prime concern and most essential need that has to procured as it necessity is present in all fields of applications. The majority of the research are going around the durability of the data , the requirement of which has now became a big challenge in front of researchers and industries. The current trend in data storage research involves multidimensional storage , usage of materials , mode of retrieval etc . optical mode of storing the data offers high density storage as it stores the data in the form of patterns along with this it also offers high speed transmission and retrieval. By implementing the multiple polarization in the nano structured materials, the 5 dimensional data storage has been demonstrated[1]. Exploration of plasmonic materials and Plasmon modes in noble materials like Au towards the storage of energy is done by solving Maxwell's equations[2]. the resonant behaviour of metallic nano particles or dielectric nano structures are adopted and manipulated in high density optical data storage systems by varying the dimensions of the nano structures different resonant variations are achieved[3]. With the help of photonic based technology, not only biological sensors but also large data storage devices can be constructed to incorporate optical data in a large area of pits and ditches made over a very minute landscape of silicon substrate. Silicon wafer technology is a very inexpensive market product and their utilization in photonic based devices demands customization for chemical mechanical planarization. These wafers are to undergo same processes as that of microelectronic component manufacturing[4-10].

Surface plasmonics:

In early 1980's and 1990's Surface Plasmon resonance [SPR] was known only for biosensors. But its capability of switching between photons to plasmons and its resonant behaviour over specific wavelengths in response of change in the refractive index in the intended area and with varying surface geometrical calculations makes it very compatible for optical data storage[5].SPR can be termed as a continuous free electron density oscillations known as Surface Plasmon poloritons, a transformation product of incident photons when makes contact with a metal–dielectric interface. In other words the interaction between the light and the sub wavelength metallic nano- particles like gold and silver gives rise to plasmons .The significant response of plasmons are highly impulsive with the variation in the refractive index in the region of interest, resulting in wavelength shift.

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PROPOSED STRUCTURE:

Figure 1:proposed design for the metal dielectric data storage

The proposed design consists of three layers SIO2 as a substrate , silicon as data layer ,and aluminium layer with nano apertures and a protection layer when the apertures are illuminated with the photons ,the data is stored in terms of electromagnetic flux magnetic flux.The layer description are given in the table below. Here structure area with 1nm^2 with 0ne aperture of volume 0.25nm^{3}in considerd and simulated.

Layer	**Dielectric constant value**	**Thickness in µm**
Dielectric layer(SiO_2)	2.16	4.5µm
aluminium	-22.4	10µm
Data layer	11.56	2.5µm
Lower Dielectric layer	2.16	10µm

Results and discussion:

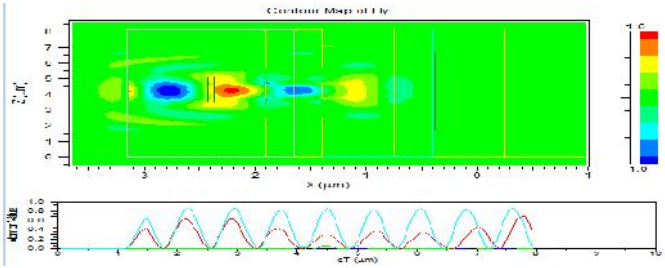
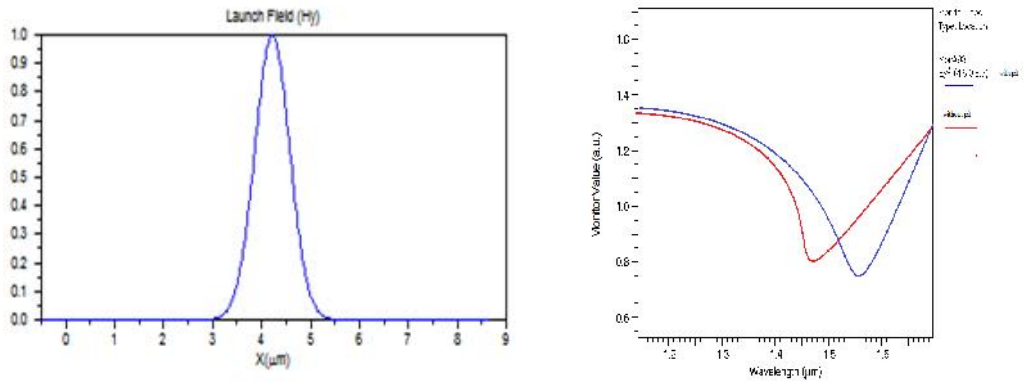


Figure 2: excitation of light inside the aperture

The above figure describes about the transmission of light inside the cavity with respect to time durations.the colour variation describes the variation in the intensity of the signal. The aperture/ the metal layer is illuminated at 1.55µm.



(a)transmitted spectrum (b)Reflected spectrum

Figure 4(a)&(b): transmitted and reflected spectrum

The above figure shows the spectral behaviour of the unit cell for monitor power w.r.t wavelength is considered and the resonance for the pit volume 0.25nm^3 is occurring at 1.5761µm.

Conclusion:

In this paper an optical data storage in silicon layer has been demonstrated. Instead of using nano structured materials and meta materials for data storage, we have used silicon as the storage layer. Simulations are done using FDTD.the aperture shows the distinct behaviour by exhibiting resonance at 1.5761µm

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