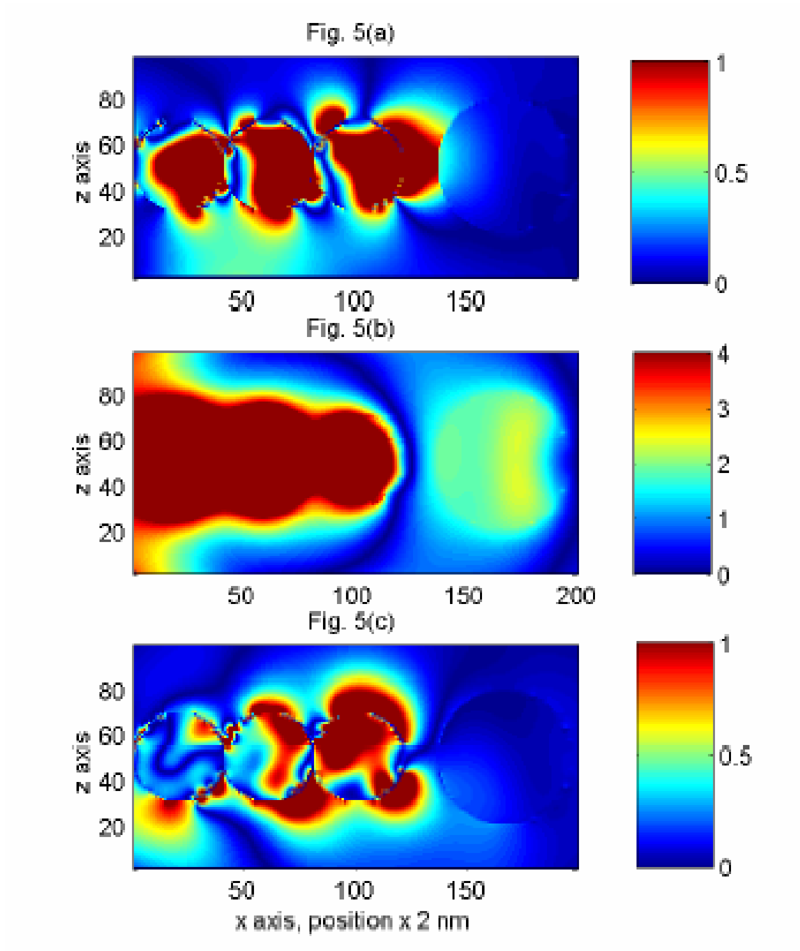

Fig. 9.4a - c show the x-z sectional plane map of the three electric field components about the case in Fig.9.3c(E_z,E_x,E_y) from top to bottom

9.2.4 A promising design for the near-field microscopy using the photonic crystal.

As mentioned in above section, if some metallic particles spheres were used as the a extra defect region in a PCs, the field enhancement is anticipated with the local mode of the surface plasmon-polariton at the surface or inside the PCs. In this section, we demonstrate these merits for our latter discussion in NSOM. An idea we combines line defects and point defects (using the metallic particle in the spherical chains) to make a novel PCs in NSOM application. The surface profile of the dielectric specimen (refractive index=1.5) consists of a °at surface with a single spherical protrusion whose diameter is 60 nm. The PCs is illuminated normally from below and the light intensity of the specimen on the surface facing the probe is detected in the far-field region (collection-type NSOM). Based on our FDTD simulations for such a PBG structure without a defect reveal a band gap in them , y direction, corresponding to the minimum width of the band gap[35]. Once we have a band gap, a defect was introduced into the 3-D structure considered above by removing one of the rows of air cylinders periodically along the x-axis and inserting spherical chains doped with aluminum particles randomly with a defect period $T = 10\sqrt{3}a$ along y axis in such region to trap or localize light. This introduces a single guide-mode band inside the gap. An intriguing aspect of PCs waveguide is that they provide a unique way to guide optical light, tractably and efficiently, through narrow channels of defect line and the FDTD analysis shows that the illumination in a PBG structure with a defect may propagate along a narrow channel [35]. Once light is introduced inside the waveguide, it has nowhere else to go where one channel is dropped at one carrier wavelength, leaving all other channels unaffected (without any interaction between light propagation in neighboring defects zone). The PCs present a unique opportunity to investigate the possibilities of miniaturizing devices to the scale of the wavelength of interest, 1550 nanometers and we can use them to select a single channel with a very narrow line width. The intensity of the electric field distribution in x-z and x-y sectional plane calculated for 5-period PBG structures whose fragment is shown in Fig. 9.5 is $a/\lambda = 0.454$ is presented in Fig.9.6. The light beam is channeled along the defect in such a structure, and the field is localized at the center and the rims of the spherical chains. The interaction between the PCs and the field near the specimen surface is an important mechanism in the formation of NSOM images. When the effects of multiple scattering by the probe tip are taken into account, we can also regard the specimen, PCs and probe as one system in the process of image formation. On the other hand, the evanescent field propagating from the probe apex can transform to radiation wave, which can receive by photo-detector. In order to study the field intensity produced by different distances between PCs and specimen was varied. We can calculate the total field distribution intensity along y-z sectional plane at several different spacing between the specimen and PCs (the results is not showed here). Roughly speaking, the existence of dielectric specimen in front of the PCs influences slightly the field distribution inside the PCs, but change the field distribution emerging from the PCs. This is because at PCs-specimen distance the effect of multiple scattering or the image formation process becomes negligible and the image is generated primarily by the coupling effect of the near-field to the wave-guide structure of the PCs. The specimen divided the emerging light from the PCs into two parts, one penetrates through the specimen, the other distribute between specimen and PCs. We can obtain the characteristics of specimen surface by way of penetrating light through the specimen. The photo-detector not only detects directly the field distributes between PCs and specimen but can detect the emerging light from the PCs, including the light refraction from the specimen surface. Hence, the generated NSOM intensity image exhibits stronger values at both the rim of the spherical chains and the flat sample surface than the PCs-specimen interaction are not included. It propagates along the surface of the specimen and creeps latterly along the sample surface acting the characteristic of reflection light. In the rim of spherical chains in the PCs, multiple scattering occurs between PCs and the specimen, but is not coupled with the propagation mode of the tip transmission.

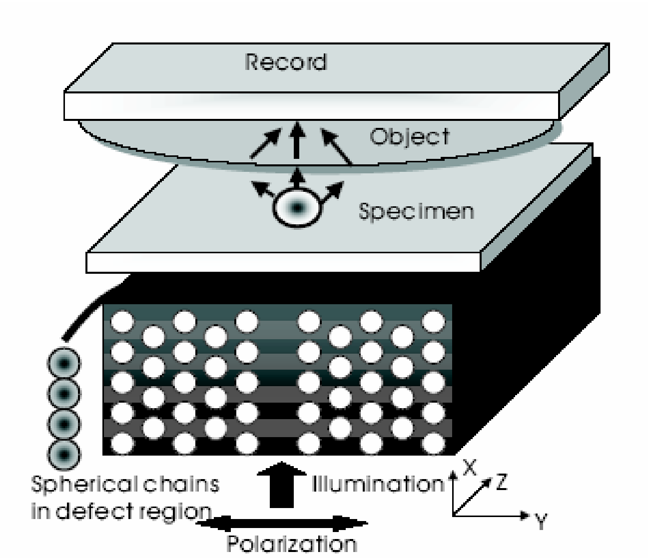

Fig. 9.5 Fragment of near field optical microscopy using an evanescent wave formed in the defect mode of a PCs. A PBG structure is used to excite the evanescent wave with recording in the far field.

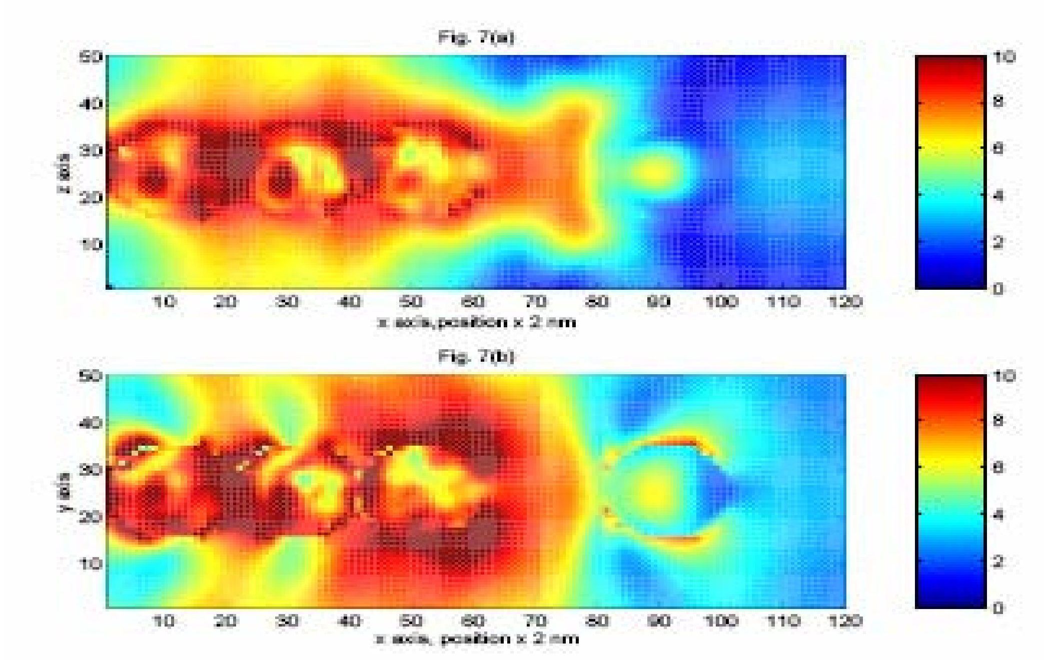

Fig. 9.6 The 3-D distribution of the mean intensity of the electric field in x-z and x-y sectional plane calculated for 5-period *PBG* structures whose fragment is shown in Fig. 9.5 is a/λ =0.465

9.2.5 The future work

In conclusion, we have presented a numerical method for calculating defect modes in 3-D PCs in NSOM. We used a particular substance which was doped some metallic particles or embedded inside the spherical chains as an extra defect substance in the defect region. The results of these calculations show that the evanescent fields formed in the defect regions of PCs can be used for NSOM system with spatial resolution exceeding the wavelength of the incident illumination and obtaining a fairly high SNR (signal to noise ratio). The high density of optical field at the output from this structure of PCs may give arise to physically observable phenomena in the near field zone. Many applications by using these properties arising from the field at the output of such a PBG structure are associated with the chances of enhancing the spatial resolution in photolithography, promoting the data storage capability in optical memory systems and also for controlling atoms and atoms interactions in quantum calculation problems as well as other applications. In the near future, we will investigate the field distribution and transmission spectra of spheres arranged separately in order or disorder in the defect region of PCs using FDTD or multiple scattering method in NSOM.

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