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Research Paper

PHYSICS

Effects of transmission spectra of the metallic photonic crystal (MPC)

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ABSTRACT

The effect of transmission spectra of the metallic photonic crystals show that first transmission band of the metallic Photonic Crystals (MPC) occur at Bragg condition and in MPC the P-Polarized waves is less sensitive to the incident angle than the S-Polarized waves.

KEYWORDS : Transmission; Metallic Photonic Crystals; Dielectric Photonic Crystals; Photonic Band Gap

2.2. Metallic Photonic Crystals (MPCs)

We have shown in the previous section that, in order to achieve photonic band gap, the system must has high contrast in the refractive index with negligible the absorption of light. These conditions have restricted the set of dielectrics that exhibit a photonic band gap[2]. One suggestion is to use metals which have large value of dielectric permittivity rather than dielectrics. Accordingly a fewer numbers of periods would be enough to achieve photonic band gap [6]. We have designed 1D-MPC composed of Cryolite/Silver with 10 periods, lattice constant = 210 nm, and the filling factors of Silver and Cryolite are 0.0476, and 0.9634, respectively. The dispersion has been taken into account by using Drude model and then we can calculate the refractive index of metals. The transmission spectra of the MPC are displayed in Figure 1. As shown in the figure, the MPC present like the DPC alternation of transmission bands and band gaps with the same progressive decrease of the transmission contrast. However for low frequency region starting from zero frequency of the spectrum, MPC ex-hibit plasmonic band gap. This plasmonic gap extends from 309.3 THz (970 nm) to zero frequency. This band gap not originated from the structure but from the bulk silver properties. In addition to the plasmonic band gap, the MPC exhibits structural band gap extends from 420 to 570 nm. The structural band gap follows the first transmission band that extends from 570 to 970 nm. The Plasmonic band gap is followed by a first transmission band whose centre wavelength corresponds to Bragg condition. The situation here turns out to be reversed compared to the case of the DPC, where the same exact relation corresponds to the first band gap[4]. The value of the centre wavelength of the first transmission band determined from Bragg condition (750 nm) nearly consistent with the value deduced from the transfer matrix method shown in Figure 1. The first transmission band or the band gaps of the MPC can be tuned by varying n or Λ as in the DPC.

Figure 2 shows the transmission spectra of the previous designed MPC at the number of periods equal to five periods. By decreasing number of periods, no change in the S-polarized wave has shown blue shift larger than the P-polarized wave.

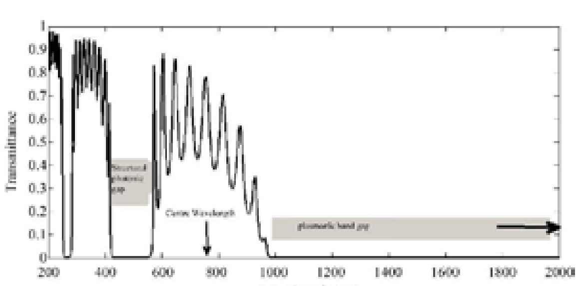

Figure:1. Calculate transmission spectra of MPC composed of Cryolite/Silver with d1 = 200 nm, d2 = 10 nm, number of periods = 10, and θ = 0˚.

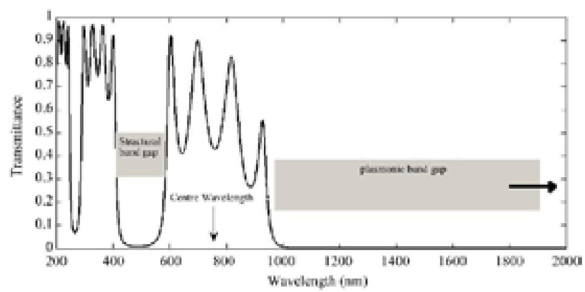

Figure: 2 Calculated transmission spectra of MPC composed of Cryolite/Silver with d1 = 200 nm, d2 = 10 nm, θ = 0˚, and periods = 5.

The 1D-MPCs can work as mirrors because it needs fewer numbers of periods to give high reflectance gap[5]. Plasmonic gap of the MPC block the longest wavelengths (microwaves and radiofrequency) and this makes it to work as radiofrequency shield and microwave ovens doors. It also can work as UV protective.

3. Conclusion

The MPC has both structural and bulk metal band gaps, on contrary to the metallic photonic crystal that begins with stop band and the first transmission band of the MPC occur at Bragg condition. the MPC the *P*-Polarized waves is less sensitive to the incident angle than the *S*-Polarized waves MPCs of larger damping coefficient metal have lower transmittance, and MPCs of larger Plasmon frequency metal have resonance trans-mission peaks at shorter wavelengths. Increase the metal filling factor of the MPC do as the Plasmon frequency of the metal increase.

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