Chapter 4 Conclusion and perspective

4-1 Conclusion

An incident photon excites a QP (quasi-particle) from the periodic background dielectric constant in PCs (photonic crystals) behind K.P theory. The QP has inertial mass and the periodic dielectric constant forms an effective dielectric constant to modify the action of the light. As a defect is added, a potential well is created. The trapping effective is similar that in quantum in mechanics. In the dielectric defect of PCs, the potential is negative and defect mode frequency appears near the air band when slight defect is added. The more disorder is added the lower frequency it is. Contrary, in the air defect the potential is positive but the effective dielectric is positive. When slight air defect is added, the defect mode frequency is appeared near the dielectric band edge. And the more disorder is added, the higher frequency it is.

In 1-D defect PCs, any arbitrarily small defect can bind a state. But in 2-D or 3-D PCs, finite defect is needed to bind a stat. This is the same with potential well in quantum mechanics. We use K.P theory to derive a master equation and use the equation to solve the bound state frequency of several structures in 1-D and 2-D PCs. By comparing with the simulation results of TMM and MPB, they match quite well especially when the defect is small. At same time we calculate the exponential decay rate of the electric field away from the defect with K.P theory and TMM. The simulation results also match quite well.

K.P theory provides an approximate approach to study the phenomenon of the light

traveling in the PCs. The practical usefulness of K.P method is that these K.P parameter can be obtained by fitting either to band structure of bulk PCs calculated using computationally intensive methods ,i.e., Plane-wave expansion method or TMM, or to available experimental data. Knowledge of these bulk K.P parameters will allow the K.P theory to describe several novel structures such as super-lattices, hetero structure and slowly-varying defect.

4-2 Perspective

In this paper, the trapping phenomenon of the light in several 1-D structures is concerned. In 2-D case, we mainly deal with a plane wave normally incident into a line defect PCs with hetero-structure. Because the effective dielectric constant and band gap is directional dependent, there is some difficulty in dealing point defect such as deciding potential and effective dielectric constant. So using K.P method to solving point defect in 2-D or 3-D PCs can be another further research. Beside, when the light is incident into a line defect of PCs in the frequency of the defect mode, the light will travel in the defect. We should use K.P theory to study this phenomenon.

Besides using K.P method, the numerical method to solving 2-D or 3-D PCs such as Plane wave expansion method, TMM and FDTD should be developed. Because K.P method is an approximation method, it can help us to expand to the simulation result of other numerical methods. But we still need other methods to get more precise solution.