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论文

光子晶体表面结构的改变对成像的影响

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摘要:

负折射率材料因为其奇异的特性成为广泛研究的对象,尤其是光子晶体平板的完美成像.硅材料以其良好的物理性质成为当今集成光学领域中应用最广的材料之一.本文以硅介质柱在空气中周期性排列构成六角结构的光子晶体平板为例,运用平面波展开法进行光子晶体能带计算并运用时域有限差分法模拟改变光子晶体平板成像并讨论表面结构对成像的影响.光子晶体平板等效折射率为-1时,通过改变上下侧最外层介质柱的半径或是侧向移动最外层介质柱发现:当光子晶体平板表面结构发生改变时光子晶体平板仍能成像但像点强度发生变化.当光子晶体平板表面结构的改变在一定范围时,所成像的位置发生改变且位置变化符合光子晶体成像经典的Veselago关系;当光子晶体表面结构的变化超过该范围时,所成像与物的相位发生反相同时像点位置发生"巨变",此时Veselago关系已不成立.数值模拟表明:光子晶体平板表面结构的改变可以有效地改变该光子晶体平板所成像的强度、位置和相位.

关键词: 负折射材料 光子晶体 成像 表面结构 时域有限差分法

Effect of Changing Surface Structure of Photonic Crystals on Image

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Abstract:

Negative index material is one of wide research objects because of its unique characteristics, especially perfect imaging of photonic crystal slab. Silicon is a kind of the most widely applied materials in the integrated optical field because of its physical properties. In this paper, Si cylindrical rods are designed into hexagonal pattern in air to build a 2D photonic crystals flat. Band structure of this photonic crystals is calculated by the plane wave expansion method and the finite difference time domain method is used to simulate the effect on imaging when the surface structure of photonic crystals flat is changed. The simulation results show that photonic crystals slab can still image but image intensity will change by changing the both outermost radius or shifting outermost layer column laterally as photonic crystal slab equivalent refractive index is -1. And the position of image change and it changes accord with the classic Veselago relation of photonic crystal imaging as the surface structure of photonic crystals slab is changed in a certain range. But the phase difference of image and source will be 180° if the surface changes beyond this range and at the same time the image position will change sharply and the source and image will go against the Veselago relation. From the results it can be included that it can change the image intensity, position and phase effectively by changing the surface structure of photonic crystal slab.

Keywords: Negative Index Material(NIM) Photonic Crystals(PCs) Imaging Surface structure Finite Difference Time Domain(FDTD)

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