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发光学应用及交叉前沿

超导-介质型Fibonacci光子晶体的透射谱与滤波特性分析

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摘要： 目前广泛应用的可调谐光滤波器通过调节干涉腔长度来实现波段的调谐。它需要制备高反射悬浮膜,而悬浮膜在驱动电压的影响下其运动会受到限制,且较窄的透射峰与较大的调谐范围二者不可兼得。为此,本文将光子晶体中的其中一种介质以超导材料取而代之。基于超导理论,利用传输矩阵法对一维超导-介质型Fibonacci光子晶体的透射谱进行了计算,讨论了厚度、折射率以及温度对透射谱的影响。结果表明,受光子带隙的影响,超导体的频率禁带中会出现一系列的通带;Fibonacci等级的增加会导致第一透射峰更加尖锐;介质层光学厚度增大、超导层厚度减小、温度升高均能使透射峰向长波方向移动。最后,在透射谱分析的基础上给出了结构为$S_{11}(S_5)^n$的滤波特性,兼顾透射峰半高宽与可调谐范围,确定了滤波器的可调谐波段,在无需调整任何几何参数的条件下实现了温控调谐。

关键词： Fibonacci光子晶体 超导 传输矩阵法 温控调谐

Transmission Spectra and Filter Property Analysis of Superconductor-medium Fibonacci Photonic Crystal

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Abstract: The tunable optical filter is widely used to tuned the waveband by adjusting interference cavity length. It needs to prepare high reflective suspended membrane. However, the moving of suspended membrane is restricted under the influence of the driving voltage. The narrow transmission peak and the large tuning range are hard to be satisfied at the same time. Therefore, one of the media in photonic crystal is replaced with superconductor material in this paper. Based on superconducting theory the transmission spectra of one-dimensional superconductor-medium Fibonacci photonic crystal are calculated by applying transfer matrix method. The effect factors on transmission spectra of parameter such as Fibonacci level, refractive index of medium layer, thicknesses of medium and superconductor layer, temperature are discussed. The results show that a serious of passing band appears at the forbidden band of superconductor because of the influence of photonic band gap. The first transmission peak becomes sharper with the increasing of Fibonacci level. The transmission spectra move towards the long wave direction when the optical thickness of medium layer increases, the thickness of superconductor layer decreases and temperature rises. At last, based on analysis of spectra, the filter property of structure expressed as is given. Besides, the tunable band of filter is determined on condition that the half-width and tunable range are both considered, and temperature-controlled tuning is achieved without adjusting any dimension parameters.

Keywords: Fibonacci photonic crystal superconductivity transfer matrix method temperature-controlled tuning

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