

光子晶体激光器设计

电子科学与技术学院电子科学与技术专业 谢晓华

(学号: 2007160016)

指导教师: 陶科玉

摘要: 光子晶体微腔激光器具有极低的阈值以及便于集成化的优点,是一类有前途的集成光子器件。本论文研究半导体材料制成的二维三角格子光子晶体微腔结构。首先,采用平面波展开法计算了微腔结构的缺陷模频率,并用时域有限差分法进行了仿真分析。计算发现,通过改变光子晶体在径向空气孔的个数和调整缺陷周围最邻近的空气孔半径、形状以及其位置,可以使得缺陷模的品质因子提高,从而提高激光器的工作性能,降低激光器的发射阈值。参数的优化结果表明:当最邻近孔的半径或者形状分别与孔的位置同时改变时,最邻近孔径向往外挪动 0.200α ,单模在平面内有最大的 Q 值,此时圆孔半径 r' 为 0.2α ,或者类椭圆孔长轴 A 为 0.6α 。

关键词: 光子晶体微腔; 品质因子; 非简并单模; 时域有限差分法; 平面波展开法

Design of a photonic-crystal-cavity laser

Abstract: Photonic-crystal-cavity laser has the advantage of extremely low threshold and is easy to be integrated. In this thesis, I study modes of a single-cell photonic-band-gap laser cavity which is formed by a two-dimensional triangle lattice. In order to design a photonic-crystal micro-cavity with a high- Q factor, Plane Wave Expansion Method and Finite-difference Time-domain method are employed. We simulate the air hole array photonic crystal defected cavity inside a semiconductor material. Furthermore, the resonant frequencies and the in-plane quality factors in cavity are calculated. It is found that the values of Q are influenced by factors such as: the numbers of air holes along the Γ -K direction, the radius, shapes and locations of the nearest-neighbor holes around the defect. To improve the performance of lasers and to decrease the lasing threshold, we optimized the parameters. The in-plane quality factor of the monopole will be a maximum value when the nearest-neighbor holes have moved outwards to 0.200α from their original positions while the radius r' should be 0.2α , or the elliptical major axis be 0.6α .

Key Words: photonic-crystal cavity; quality factor; non-degenerate monopole mode; FDTD method; PWEM method

教师点评: 该毕业论文主要研究了光子晶体微腔结构激光器的优化设计。采用了平面波展开法计算微腔的能带结构,应用时域有限差分法进行了各模式的场分布及相关品质因子计算。论文结果表明:临近中央缺陷的小孔尺寸、形状和位置等因素对品质因子有较大的影响。该同学对不同参数的匹配进行了优化仿真。对于本科毕业设计而言,计算工作量大。该论文内容完整,结构安排合理,书写格式规范,是一篇优秀的毕业论文。