

论文

GaAs半导体激光器线宽展宽因子的理论计算

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摘要:

本文利用简单模型综合考虑了带间跃迁、自由载流子吸收和带隙收缩对半导体激光器线宽展宽因子的影响,给出了半导体激光器线宽展宽因子的一种较为简便的计算方法.首先从理论上推导出线宽展宽因子的计算公式,分析并计算了GaAs半导体激光器的增益特性,并使用MATLAB软件中的Mupad工具包求解费米积分的数值解.然后根据得到的增益拟合曲线峰值的变化计算了带间跃迁对线宽展宽因子的影响.最后,分别讨论和计算了自由载流子吸收和带隙收缩对线宽展宽因子的影响.结果表明,带间跃迁和带隙收缩对线宽展宽因子的影响较大(α 因子值分别为22.562, -6.853),而自由载流子吸收对线宽展宽因子的影响较小(只有-0.605).

关键词: 半导体激光器 线宽展宽因子 增益 自由载流子吸收 带隙收缩

Theoretical Calculation of Linewidth Enhancement Factor in GaAs Semiconductor Lasers

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Abstract:

The effects of interband transition,free carrier absorption and bandgap narrowing on linewidth enhancement factor (α factor) in semiconductor lasers were comprehensively considered in a simple model.A convenient calculation method of α factor in semiconductor lasers was presented.The formula for α factor was derived at first,the gain of GaAs semiconductor lasers was theoretically analyzed and calculated,and the process of solving the Fermi integral function by taking advantage of the Mupad notebook in MATLAB software was introduced.Further,the effect of interband transition on α factor was calculated based on the peak variation of gain fitting curves.Finally,both the effects of free carrier absorption and bandgap narrowing on α factor were discussed,respectively,and their values were obtained.The results show that interband transition and bandgap narrowing have more obvious effects on α factor in semiconductor lasers (α factor are 22.562 and -6.853,respectively) than the effect of free carrier absorption(α factor is only -0.605).

Keywords: Semiconductor lasers Linewidth enhancement factor Gain Free carrier absorption Bandgap narrowing

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参考文献:

- [1]HENRY C H.Theory of the linewidth of semiconductor lasers[J].IEEE Journal of Quantum Electronics,1982,18(2): 259-264.
- [2]VILLAFRANCA A,VILLAFRANCA A,GIULIANI A,et al.Mode-resolved measurements of the linewidth enhancement factor of a Fabry-Pérot laser[J]. IEEE Photonics Technology Letters,2009,21(17): 1256-1258.
- [3]GERHARDT N C,HOFMANN M R,HADER J,et al.Linewidth enhancement factor and optical gain in (GaIn)(Nas)/GaAs lasers[J].Applied Physics Letters,2004,84(1): 1-3.
- [4]MACKENZIE R,LIM J J,BULL S,et al.Measurement of optical gain,effective group index and linewidth enhancement factor in 1.3 mm dilute nitride double-quantum-well lasers[J].IET Optoelectron,2007,1(6): 284-288.
- [5]MELNIK S,HUYET G,USKOV A.The linewidth enhancement factor α of quantum dot semiconductor lasers[J].Optics Express,2006,14(7): 2950-2955.
- [6]OHTOSHI T,CHINONE N.Linewidth enhancement factor in strained quantum well lasers[J].IEEE Photonics Technology Letters,1989,1(6): 117-119.
- [7]AGRAWAL G P,BOWDEN C M.Concept of linewidth enhancement factor in semiconductor lasers: its usefulness and limitations[J].IEEE Photonics Technology Letters,1993,5(6): 640-642.
- [8]SEO W H,DONEGAN J F.Linewidth enhancement factor of lattice-matched InGaNs/GaAs quantum wells[J].Apply Physics Letters,2003,82(4): 505-507.
- [9]KANO F,YAMANAKA T,YAMAMOTO N,et al.Linewidth enhancement factor in InGaAsP/InP modulation-doped strained multiple-quantum-well lasers[J].IEEE Journal of Quantum Electronics,1994,30(2): 533-537.
- [10]LEE S S,FIGUEROA L,RAMASWAMY R.Variations of linewidth enhancement factor and linewidth as a function of laser geometry in (AlGa)As lasers[J].IEEE Journal of Quantum Electronics,1989,25(5): 862-870.
- [11]HUANG Y,ARAI S,KOMORI K.Theoretical linewidth enhancement factor α of Ga_{1-x}In_xAs/GaInAsP/InP strained-quantum-well structures[J].IEEE Photonics Technology Letters,1993,5(2): 142-145.
- [12]PARK S H.Linewidth enhancement factor of InGaNs/InGaNs quantum-well lasers and comparison with experiment[J].Journal of the Korean Physical Society,2004,45(4): 1085-1088.
- [13]HOCHHOLZER M,JORDAN V.Discussion of the linewidth enhancement factor α of GaAs/GaAlAs quantum well lasers[J].IEE Proi-Optoelectron,1994,141(5): 311-315.
- [14]PENG Yu-heng,CHENG Song-yan,CHEN Wei-you,et al.The theoretical analysis of gain and linewidth enhancement factor of modulation-doped compress strained multi-quantum-well lasers[J].Acta Electronica Sinica,1996,24(11): 33-37.
- 彭宇恒,陈松岩,陈维友,等.调制掺杂压缩应变多量子阱激光器的增益特性和线宽增强因子的理论研究[J].电子学报,1996,24(11): 33-37.
- [15]杜宝勋.半导体激光器原理[M].北京:兵器工业出版社,2004.
- [16]LU Hong-chang,LUO Bin,CHEN Jian-guo.Measurement of linewidth enhancement factor of semiconductor lasers[J].High Technology Letters,1996,6(2): 12-14.
- 吕鸿昌,罗斌,陈建国.半导体激光器谱线展宽因子测量[J].高技术通讯,1996,6(2): 12-14.
- [17]YU Yan-guang,YAN Yan-xia.An approach for measuring parameters of semiconductor lasers[J].Laser & Infrared,2006,36(2): 114-117.
- 禹延光,闫艳霞.半导体激光器线宽展宽因数的估计方法[J].激光与红外,2006,36(2): 114-117.
- [18]YU Yan-guang,YUAN Xiu-juan.Automatic measurement of the linewidth enhancement factor based on moderate optical feedback[J].Chinese Journal of Lasers,2008,35(1): 97-101.
- 禹延光,袁秀娟.适度光反馈机制下线宽展宽因数的自动测量[J].中国激光,2008,35(1): 97-101.
- [19]栖原敏明.半导体激光器基础[M].周南生,译.北京:科学出版社,2002: 47.
- [20]PIPREK J.Semiconductor optoelectronic devices[M].California:Academic Press,2003: 7,94.

本刊中的类似文章

1. 楚晓亮;张彬.超短脉冲在放大介质中传输特性研究[J].光子学报,2004,33(6): 641-644
2. 杜晨林;阮双琛;于永芹;秦连杰;邵宗书;孟宪林.LD泵浦Nd:GdVO₄/GaAs被动调Q激光器研究[J].光子学报,2004,33(7): 774-776
3. 邓华秋;龙青云.反向抽运光纤喇曼放大器增益特性分析[J].光子学报,2006,35(10): 1534-1537
4. 朱孟正 赵春然 尹新国 李光源 .开放四能级原子系统粒子数反转或无反转激光研究[J].光子学报,2007,36(12): 2360-2364
5. 李成仁;宋昌烈;李淑凤;李建勇;雷明凯.阶跃掺杂Er:Al₂O₃光波导放大器增益特性数值模拟[J].光子学报,2006,35(2): 192-196
6. 刘元山;张建国;赵卫.内置RF电路对增益开关工作的不利影响[J].光子学报,2007,36(1): 13-17
7. 丁长林;万重怡.高压CO₂激光器宽带输出频谱特性的理论研究[J].光子学报,2007,36(1): 21-26
8. 杨春晖 许艳波 王锐 徐玉恒.近化学计量比Ce:Mn:LiNbO₃晶体光折变性能研究[J].光子学报,2007,36

(5): 909-911

9. 周亚训;陈芬;徐铁峰;聂秋华.宽带放大器用碲基掺铒光纤结构参量的设计考虑[J].光子学报,2006,35(7):1038-1042

10. 檀承志 胡贵军 史新亮 .小波变换用于半导体激光器噪音信号分析[J].光子学报,2007,36(4):577-580

11. 王飞 贾新鸿 吴加贵 吴正茂 夏光琼 .包含两个半导体光放大器的锁模光纤环形激光器数值研究[J].光子学报,2007,36(4):585-590

12. 杜戈果 黎大军 李宏伟 阮双琛.1 064 nm波长双向泵浦的S波段掺铥石英光纤放大器[J].光子学报,2007,36(6):966-968

13. 桂林 文双春 .饱和放大情形下光纤参量放大器的增益和带宽特性研究[J].光子学报,2007,36(6):1050-1054

14. 王正平;杜晨林;张怀金;阮双琛;胡大伟;王营;许心光;王继扬;邵宗书.LD泵浦Nd:LuVO₄/Cr⁴⁺:YAG被动调Q激光器[J].光子学报,2006,35(8):1130-1132

15. 陈晨;辛国锋*;刘锐;瞿荣辉;方祖捷.半导体激光器热弛豫时间测试技术研究[J].光子学报,2006,35(8):1142-1145

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