光子学报 2012, 41(2) 148-153 DOI: 10.3788/gzxb20124102.0148 ISSN: 1004-4213 CN: 61-1235/O4

论文

基于离子交换条波导的生物溶液浓度传感研究

邹任玲[1], 陈抱雪[1b,2], 王悠悠[1b], 隋国荣[1b], 矶守[3]

1. 上海理工大学 a.医疗器械与食品学院;b.光电信息与计算机工程学院,上海 200093;
2. 上海市现代光学系统重点实验室,上海 200093;
3. 日本东京农工大学 工学院应用化学系,日本 184-8588

摘要：

提出并实施了一种实验推定离子交换单模条波导折射率分布的新方法,给出扩散系数可用常量等效的离子交换条件,导出了条波导离子交换制备过程的两维扩散方程的一般解,拟合推定了离子交换条波导的折射率分布.多波长测试的折射率色散通过引入玻璃色散关系解决,样品测试中表征导模吸收损耗的传播常量虚部由KK变换确定.在此基础上,试制了光纤-条波导-光纤一体化传感器结构,验证实测了多种不同浓度的葡萄糖溶液,最低检测限为0.1 μM,实现了低浓度微量测试,验证了条波导传感机制的有效性.

关键词： 集成光学 条波导 溶液浓度传感 离子交换 光波导技术

Biochemical Solution Concentration Sensing Using Stripe Waveguides Based on Ion Exchange Technology

ZOU Ren-ling[1], CHEN Bao-xue[1b,2], WANG You-you[1b], SUI Guo-rong[1b], MAMORU Iso[3]

1. a. The College of Medical Instrument|b. The College of Optical and Electron Information Engineering, University of Shanghai for Science and Technology,Shanghai 200093,China;
2. Shanghai Key Laboratory of Modern Optical System,Shanghai 200093,China;
3. Department of Chemical Engineering,Tokyo University of Agriculture and Technology,Tokyo 18428588,Japan

Abstract:

An innovative method that refractive index distribution of single-mode ion exchange is reckoned using an experimental way was proposed and implemented.The key conditions are that a diffusion coefficient must be constant.Then two-dimensional diffusion equation with ion-exchange waveguide was deduced,the presumption of the ion exchange waveguide refractive index distribution of article was fitted.The Lorentz relation solved the optical dispersion problem in sensor test. Experimental results showed that characterization guided mode propagation imaginary part constants of absorption loss by the KK transform.On this basis,the trial of fiber-article waveguide - fiber optic integrated sensor was designed.The glucose concentration was measured and the detection limit was 0.1 μM.The experiments confirmed the validity of the method for a low concentration of trace tests.

Keywords: Integrated optics Stripe waveguide Solution concentration sensing Ion exchange Optical waveguide technology

收稿日期 2011-05-16 修回日期 2011-09-15 网络版发布日期

DOI: 10.3788/gzxb20124102.0148

基金项目:

国家自然科学基金(No.61077042,No.60677032)、上海市重点实验室建设项目(No.08DZ2272800)和上海市重点学科项目(No.S30502)资助

通讯作者: 陈抱雪(1955-) ,男,教授,博导,主要研究方向为光电子、集成光学.Email: bxchen55@live.cn

作者简介:

参考文献：

[1] WANG Zhen-yuan, GU Zheng-tian. Optical humidity sensor[J]. *Laser & Optoelectronics Progress*,

2007, 44(11):41-46. 王珍媛,顾铮.光学湿度传感器[J]. 激光与光电子学进展, 2007, 44(11): 41-46.
[2] HAES A J,DUYNE R P V.Preliminary studies and potential applications of localized surface plasmon resonance spectroscopy in medical diagnostic[J].Expert Review of Molecular Diagnostics,2004,4(1):527-537.
[3] CHUNG J W,KIM S D,BERNHARDT R, *et al*. Application of SPR biosensor for medical diagnostics of human hepatitis B virus 0aI-mv[J].Sensor Actuators B,2005,11(2):416-422.
[4] XIE Xiao,LIU Quan-jun,LU Zu-hong.The development of biomedical detection by optical waveguide light mode spectroscopy system[J]. *Laser & Optoelectronics Progress,* 2006,43(11):33-42. 谢骁,刘全俊,陆祖宏.光波导模式谱(OWLS)用于生物医学检测的研究进展[J].激光与光电子学进展,2006,43(11):33-42.
[5] ZOU Ren-ling,CHEN Bao-xue,WANG Hai-hong.The sensing structure optimization of planer optical waveguide with fermi refractive index [J].Journal of Lightwave Technology,2010,28(23):3439-3443.
[6] JOHANSSON J,DJANTA G,COUTAS J L.Optical waveguides fabricated by ion exchange in high-index commercial glasses[J].Applied Optics,1992,31(15):2796-2799.
[7] ALBERT J,YIP G L.Wide single-mode channels and directional coupler by two-step ion-exchange in glass[J].Journal of Lightwave Technology,1988,6(4):552-563.
[8] SUI Guo-rong,CHEN Bao-xue,ZHANG Xiao-wei,et al.Automatic waveguide-fiber coupling system based on multi-objective evolutionary algorithm[J].Applied Optics,2007,46(30):7452-7459.
[9] PEIPONEN K E,VATIAINEN E M.Kramers-Kronig relations in optical data inversion[J].Physical Review B,1991,44(2): 8301-8303.
[10] JIANG Li-ying,CAI Xin-xia,LIU Hong-min,et al.Research on biosensor for low concentration glucose determination[J].Instrument Technique and Sensor,2009,2(2):1-4. 姜利英,蔡新霞,刘红敏,等.用于检测低浓度葡萄糖的生物传感器研究[J].仪表技术与传感器,2009,2:1-4.

本刊中的类似文章

1. 贾凌华 邱枫 钱颖 提运强 郑杰 王鹏飞 G Farrell.数码照相法测量离子交换平面光波导损耗特性[J]. 光子学报, 2009,38(5): 1058-1061
2. 刘鑫,孔梅,王雪萍.损耗对串联双微环谐振器滤波特性的影响[J]. 光子学报, 2011,40(2): 247-250
3. 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
4. 肖文;伊小素.高准确度光纤陀螺中相位调制的控制研究[J]. 光子学报, 2007,36(1): 43-46
5. 万旭;彭保进;金洪震.聚合物阵列波导光栅的大范围电-光波长调谐滤波器[J]. 光子学报, 2006,35(5): 659-663
6. 韩秀友;庞拂飞;蔡海文;瞿荣辉;方祖捷.平面弯曲波导耦合器的特性分析[J]. 光子学报, 2005,34(11): 1629-1632
7. 韩秀友;庞拂飞;耿建新;蔡海文;瞿荣辉;方祖捷.跑道形玻璃波导谐振腔滤波器的研制[J]. 光子学报, 2006,35(10): 1475-1477
8. 胡建东; 文泓桥; 林志立.波导型钯(Pd)膜氢传感器数值模拟及优化[J]. 光子学报, 2005,34(2): 237-240
9. 郎贤礼;刘德森**;吕涛;蒋小平;朱少丽.二次离子交换法改进自聚焦透镜折射率分布[J]. 光子学报, 2005,34(8): 1141-1144
10. 恩德;陈才和;崔宇明;丁桂兰;刘杰.集成光学平板光盘读出头研制[J]. 光子学报, 2004,33(5): 529-532
11. 贾玉斌; 郝一龙.两个非平行波导间的能量转换[J]. 光子学报, 2005,34(6): 852-856
12. 谈振兴 于天宝 方利广 陈淑文 廖清华.超微光子晶体多模干涉型滤波器的设计与优化[J]. 光子学报, 2009,38(3): 592-596
13. 何磊;陈抱雪;袁一方;陈林;矶守.支化聚甲基苯基硅烷薄膜波导的光折变效应研究[J]. 光子学报, 2007,36(2): 229-233
14. 戚伟 余辉 郝寅雷 杨建义 王明华 江晓清 .锥形光波导中附加相位特性的分析[J]. 光子学报, 2007,36(9): 1609-1613
15. 米磊 姚胜利 李强 高凤 .一维自聚焦透镜及其应用[J]. 光子学报, 2007,36(9): 1624-1627

文章评论 (请注意:本站实行文责自负, 请不要发表与学术无关的内容!评论内容不代表本站观点.)

反馈人		邮箱地址	
反馈标题		验证码	6595
反馈内			