

## 论文

### 环圈光纤的失效预测

梁小红, 刘军号

中国电子科技集团公司第四十六研究所, 天津 300220

摘要:

以光纤的机械可靠性为主线综述了光纤材料中固有裂纹的生长和传播所导致的光纤断裂机制.在该断裂力学的基础上推导了传统通信光纤在平直应用中的寿命预测模型.继而分析了处于弯曲构型中的传感环圈光纤表面的应力分布,然后在与传统理论相同的基本断裂机理下,类比于通信光纤可靠性模型的推导,据此应力分析给出了评估这种环圈光纤的机械可靠性的一般模型.进而从工程应用的角度简化了所推导出的一般模型,使之能够快速简单地给出环圈光纤失效概率的保守评估.在此简化模型的基础上,数值计算了目前常见的几种传感环圈中的光纤在服役期间的累积失效概率;其结果同时也显示了该环圈光纤的失效概率对光纤参量、环圈参量以及工艺参量的依赖关系.根据这一依赖关系,不仅可以快速评估在各种服役应力条件下具有不同寿命要求的光纤环圈的失效概率,同时也能对这些环圈的设计提供参考.

关键词: 光纤 失效概率 机械可靠性

### Failure Prediction of Coiled Fibers

LIANG Xiao-hong, LIU Jun-hao

The 46th Research Institute, China Electronics Technology Group Company, Tianjin 300220, China

Abstract:

The mechanism of crack occurrence and propagation in optical fibers were reviewed with emphasis on the reliability of optical fibers. The lifetime prediction model of communication optical fibers were given on the basis of the fracture mechanics. The stresses distribution of optical fibers in the configuration of fiber coils was analyzed. A general model was derived for evaluating the mechanical reliability of this kind of coiled sensing fibers. The model was then simplified to an alternative model for engineering applications. This simplified model would bring the conserved results out rapidly and simply. Several numerical calculations of the failure probability in service time of various fiber coils with different fiber radius and bending radius were carried out using the simplified model. The results displayed the dependence of the failure probability on the parameters of the fibers, coils, and the process. According to the relation, the failure probability and the lifetimes could be estimated for fiber coils installed. Meanwhile, the relations provided the guidelines to various design solutions of the fiber coils with deferent geometric configurations and service conditions in the future.

Keywords: Optical fibers Failure probability Mechanical reliability

收稿日期 2012-07-30 修回日期 2012-09-04 网络版发布日期

DOI: 10.3788/gzxb20134204.0427

基金项目:

通讯作者: 刘军号(1980-),男,学士,工程师,主要研究方向为光纤光学.Email: deishi5204@163.com

作者简介:

参考文献:

- [1] NOE R. Essentials of modern optical fiber communication [M]. Heidelberg: Springer-Verlag Berlin Heidelberg, 2010.

扩展功能

本文信息

- Supporting info
- PDF(1360KB)
- HTML
- 参考文献

服务与反馈

- 把本文推荐给朋友
- 加入我的书架
- 加入引用管理器
- 引用本文
- Email Alert
- 文章反馈
- 浏览反馈信息

本文关键词相关文章

- 光纤
- 失效概率
- 机械可靠性

本文作者相关文章


[2] LECOY P. Fiber-optic communications  
[M]. New York: John Wiley & Sons, 2008.


[3] YIN S, RUFFIN P B, YU F T S. Fiber optic sensors  
[M]. 2nd ed. Boca Raton: CRC Press, 2008.


[4] RIGHINI G C, TAJANI A, CUTOLO A. An introduction to optoelectronic sensors  
[M]. Singapore: World Scientific Publishing Co. Pte. Ltd., 2009.

[5] AZADEH M. Fiber optics engineering  
[M]. New York: Springer Science+Business Media, 2009.

[6] SIVALIGAM K M, SUBRAMANIAM S. Emerging optical network technologies  
[M]. New York: Springer Science+Business Media, 2005.

[7] EVANS A G. A simple method for evaluating slow crack growth in brittle materials  
[J]. International Journal of Fracture, 1973, 9(3): 267-275. 

[8] EVANS A G, WIEDERHORN S M. Proof testing of ceramic materials-An analytical basis for failure prediction  
[J]. International Journal of Fracture, 1974, 10(3): 379-392. 


[9] RITTER J E Jr. Probability of fatigue failure in glass fibers  
[J]. Fiber and Integrated Optics, 1978, 1(4): 387-399. 


[10] KALISH D, TARIYAL B K. Static and dynamic fatigue of a polymer-coated fused silica optical fiber  
[J]. Journal of American Ceramic Society, 1981, 61(12): 518-523.

[11] MATTHEWSON M J. Optical fiber reliability models  
[C]. SPIE, 1993, CR50: 3-31.

[12] GRIFFIOEN W, BREULS T, COCITO G, et al. COST 218 evaluation of optical fiber lifetime models  
[C]. SPIE, 1992, 1791: 190-201.


[13] GLAESEMANN G S. Optical fiber failure probability predictions form long-length strength distributions  
[C]. International Wire and Cable Symposium Proceedings, 1991, 40: 819-825.

[14] MATTHEWSON M J, KURKJIAN C R, GULATI S T. Strength measurement of optical fibers by bending  
[J]. Journal of American Ceramic Society, 1986, 69(11): 815-821. 

[15] MATTHEWSON M J, KURKJIAN C R. Static fatigue of optical fibers in bending  
[J]. Journal of American Ceramic Society, 1987, 70(9): 662-668. 

[16] LIANG Xiao-hong, LIU Xiao-dong, LIU Jun-hao. A model for evaluating the mechanical reliability of coiled fibers

[J]. Acta Photonica Sinica, 2012, 41(5): 532-535. 梁小红, 刘笑东, 刘军号. 评估环圈光纤机械可靠性的模型

[J]. 光子学报, 2012, 41(5): 532-535. 

[17] WEIBULL W. A Statistical distribution function of wide applicability

[J]. Journal of Applied Mechanics, 1951, 18(3): 293-297.

本刊中的类似文章

1. 张治中; 雒江涛; 曾庆济; 刘华; 王建新; 赵焕东. 波长转换器和光纤延迟线在WDM光分组交换中的结构设计和性能研究[J]. 光子学报, 2004, 33(12): 1465-1468
2. 冯新焕; 范万德; 袁树忠; 开桂云; 董孝义. DBR掺铒光纤激光器激射波长的研究[J]. 光子学报, 2004, 33(12): 1417-1420
3. 王肇颖; 李智勇; 王永强; 倪文俊; 林冉; 李世忱. 利用普通色散位移光纤得到的超宽带超连续谱[J]. 光子学报, 2004, 33(11): 1324-1326
4. 于永芹; 阮双琛; 程超; 杜晨林; 姚建铨. 采用保偏光子晶体光纤在1.6  $\mu\text{m}$ 区域产生超连续谱[J]. 光子学报, 2004, 33(11): 1301-1303
5. 杨广强; 张霞; 林健飞; 宋继恩; 黄永清; 任晓敏. 高双折射光子晶体光纤偏振模色散测量[J]. 光子学报, 2005, 34(8): 1133-1136
6. 彭保进; 张敏; 廖延彪; 赖淑蓉; 匡武; 贺晓霞. 在 $-50^{\circ}\text{C} \sim +150^{\circ}\text{C}$ 大温度范围下用FBG测材料的三维热膨胀系数[J]. 光子学报, 2005, 34(10): 1501-1505
7. 沈乐; 郑史烈; 章献民. 侧面研磨光纤Bragg光栅的外部折射率敏感特性研究[J]. 光子学报, 2005, 34(7): 1036-1038
8. 袁明辉; 张明德; 孙小茵. 偏振模色散对非线性光纤环镜微波光子开关的影响及其补偿[J]. 光子学报, 2006, 35(7): 1008-1012
9. 文爱军; 傅炜; 潘青. 40Gb/s光纤传输单边带归零信号的产生和性能分析[J]. 光子学报, 2006, 35(3): 421-424
10. 高宏伟; 袁树忠; 刘波; 李红民; 曹晔; 罗建花; 赵健; 开桂云; 董孝义. 两级解调FBG传感复用技术[J]. 光子学报, 2006, 35(4): 569-572
11. 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
12. 梁艺军; 徐彦德; 刘志海; 苑立波. 环形光纤声发射传感器的相位调制特性研究[J]. 光子学报, 2006, 35(9): 1337-1340
13. 靳婉玲; 杨小来; 曹文华.

非线性掺铒光纤环境中超短光孤子串的产生及放大

[J]. 光子学报, 2007, 36(3): 448-451

14. 禹大宽; 乔学光; 贾振安; 孙安; 王敏. 一种新颖封装的耐高温光纤Bragg光栅温度传感器[J]. 光子学报, 2006, 35(2): 232-234

15. 谭靖; 陈伟民; 朱永; 王丁. 单轴分布式光纤传感器管线泄漏探测方法及定位理论分析[J]. 光子学报, 2006, 35(2): 228-231

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	<input type="text"/>	邮箱地址	<input type="text"/>
反馈标题	<input type="text"/>	验证码	<input type="text" value="3998"/>
反馈内容	<input type="text"/>		

Copyright 2008 by 光子学报