目录(Contents)

复旦大学光科学与工程系
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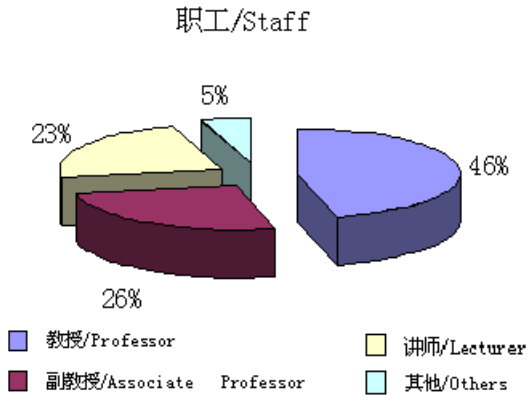
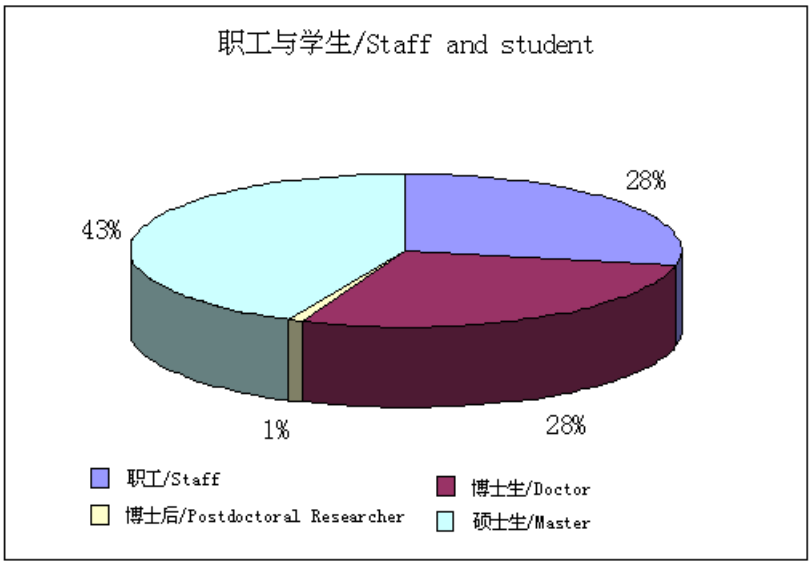
实验室概况/Overview of the Department of Optical Science& Engineering

光科学与工程系有教授 16 名，副教授 9 名。教授中包括 2 名院士、1 名长江特聘教授及国家杰出青年基金获得者、2 名国家杰出青年基金获得者、3 名跨世纪人才基金获得者。我系拥有光学国家重点学科，在“211”、“985”等高校重点学科建设中获得近 2000 万元的建设经费。在科研方面，以信息光子学领域具有重要意义和应用价值的新型光子学材料与器件作为主攻方向，侧重于基础光子学以及微光子学与纳米光子学材料和器件的研究，并适当重视光子学在交叉学科中的应用。近 5 年来，获得各类科研经费总额达 2700 多万元。我系拥有多台进口激光器、光子学器件制备系统、薄膜制备系统以及分析测试系统等设备，研究条件优越。

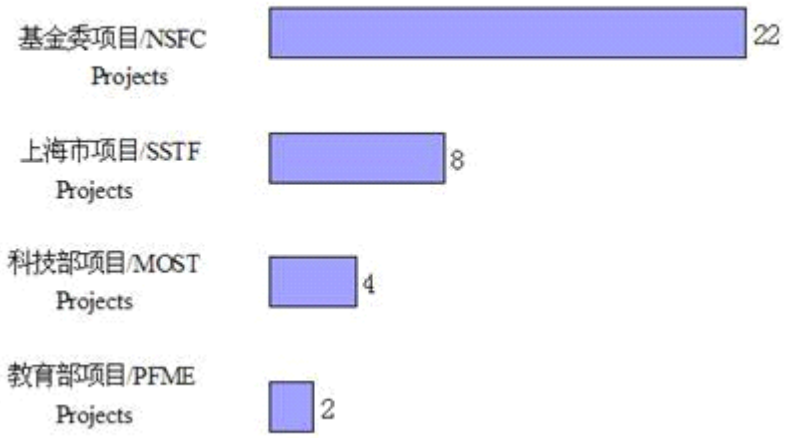
The Department of Optical Science & Engineering has 30 highly qualified faculty members, including 16 professors and 9 associate professors. Among the professors, there are one academician of the Chinese Academy of Sciences, one academician of the Chinese Academy of Engineering, one professor of “Cheungkong Scholars Program” of the ministry of education and the winner of the national distinguished youth science fund, two winners of the national distinguished youth science fund, three winners of “cross-century talent cultivation plan fund” of the ministry of education. The department boasts one national key discipline of optics, which is included in the “211 Plan” and “985 Plan” of the ministry of education and has acquired finance allocation of about 20 million yuan for constructing the discipline in the past years. The research in the department focuses on the novel photonic materials and devices of great importance and promising application in the field of information photonics, emphasizing particularly on the study for fundamental photonics, new materials and devices of micro-photonics and nano-photonics, and also paying attention to the interdisciplinary studies concerning photonics. In the past 5 years, the research fund from various programs added up to 270 million yuan. The department has a very good research environment，and is in possession of many lasers of high performance, fabricating system for photonic devices, thin film deposition system and testing and analyzing system, etc.

人事概况/General View of Personnel





在研项目概况/General View on Projects under Researching



人员结构/Organization

光科系主任/ Director

钱列加 教 授 Qian Liejia, Professor

光科系副主任/ Deputy Directors

吴嘉达 教 授，Wu Jiada, Professor

郑玉祥 教 授，Zheng Yuxiang, Professor

我系聘请的名誉教授和顾问教授/Honorary and advisory professors

N. Bloembergen Professor (美国哈佛大学，诺贝尔物理学奖获得者， Harvard University, USA)

沈元壤 院士 Y. R.Shen Academician (美国加州大学, University of California, Berkerley USA)

张国鼐 教授 R. K. Chang Professor (美国耶鲁大学, Yale University, USA)

厉鼎毅 教授 T. Y. Li Professor (美国 AT&T 公司及 Bell 实验室, AT&T Bell Lab, USA)

唐孝威 院士 Xiaowei Tang Academician (北京高能所， Institute of High Energy Physics, CAS)

徐至展 院士 Zhizhan Xu, Academician (上海光机所, Shanghai Institute of Optics & Fine Mechanics, CAS)

杨国桢 院士 Guozhen Yang, Academician (北京物理所, Institute of Physics, CAS)

侯 洵 院士 Xun Hou, Academician (西安光机所，Xian Institute of Optics & Fine Mechanics, CAS)

钟业华 教授 Yip-Wah Chung, Professor (美国西北大学, North-West University, USA)

杰出人才/ Intelligent Staff

中国科学院院士/ Academician, CAS

1980　干福熹　Gan Fuxi

中国工程院院士/ Academician, CAE

1995　范滇元　Fan Dianyuan

国家杰出青年基金获得者/National Science Fund for Distinguished Young Scholars

1994　陈良尧　Chen Liangyao

2000　金庆原　Jin Qingyuan

2007　钱列加　Qian Liejia

国家教育部“长江学者”荣誉称号获得者

1999　陈良尧　Chen Liangyao

国家教委跨世纪（新世纪）优秀人才基金获得者

1997　徐　雷　Xu Lei

2000　吴嘉达　Wu Jiada

2006　郑玉祥　Zheng Yuxiang

光科学与工程系人员名单/Name List

研究人员/ Scientific Staff

陈良尧	Chen Liangyao	孙　剑	Sun Jian
戴海涛	Dai Haitao	王培南	Wang Peinan
范滇元	Fan Dianyuan	王松有	Wang Songyou
干福熹	Gan Fuxi	韦　玮	Wei Wei
金庆原	Jin Qingyuan	吴嘉达	Wu Jiada
李　晶	Li Jing	吴　翔	Wu Xiang
李毅刚	Li Yigang	徐　雷	Xu Lei
刘建华	Liu Jianhua	许　宁	Xu Ning
刘丽英	Liu Liying	应质峰	Ying Zhifeng
陆　明	Lu Ming	张　浩	Zhang Hao
马　斌	Ma Bin	张荣君	Zhang Rongjun
糜　岚	Mi Lan	张宗芝	Zhang Zongzhi
倪　刚	Ni Gang	郑玉祥	Zheng Yuxiang
彭　波	Peng Bo	朱鹤元	Zhu Heyuan
钱列加	Qian Liejia	庄　军	Zhuang Jun

技术人员/Technical Staff

戴祝萍	Dai Zhuping	胡谊梅	Hu Yimei
徐新民	Xu Xinmin	张敏毅	Zhang Minyi
杨月梅	Yang Yuemei		

博士后/Postdoctoral fellows

高洪跃	Gao Hongyue

博士生/ Ph.D Students

张　豫	Zhang Yu	罗　航	Luo Hang
张艳武	Zhang Yanwu	袁　鹏	Yuan Peng
邬云华	Wu Yunhua	何子安	He Zian

魏小红	Wei Xiaohong	谢逸群	Xie Yiqun
刘　伟	Liu Wei	尚　磊	Shang Lei
王　科	Wang Ke	杨　佩	Yang Pei
廖嘉霖	Liao Jialin	张启明	Zhang Qiming
任　杨	Ren Yang	李晓凡	Li Xiaofan
周薇溪	Zhou Weixi	胡婧婷	Hu Jngting
周　靖	Zhou Jing	沈轶群	Shen Yiqun
张　鹏	Zhang Peng	胡　巍	Hu Wei
张　尉	Zhang Wei	李　皓	Li Hao
毛鹏辉	Mao Penghui	赵　源	Zhao Yuan
魏慎金	Wei Shenjin	邱　娉	Qiu Ping
邱静燕	Qiu Jingyan	李颖峰	Li Yingfeng
任红艳	Ren Hongyan	陈　英	Chen Ying
张　弛	Zhang Chi	涂　鑫	Tu Xin
单　炯	Shan Jiong		

硕士生/ Master Students

周信传	Zhou Xinchuan	潘苏醒	Pan Suxing
刘明辉	Liu Minghui	赵　慧	Zhao Hui
李政皓	Li Zhenghao	徐　明	Xu Ming
魏　崃	Wei Lai	俞　丹	Yu Dan
邵　劼	Shao Jie	吴　遐	Wu Xia
唐隽逸	Tang Juanyi	戴仲鸿	Dai Zhonghong
赵佳琦	Zhao Jiaqi	方　芳	Fang Fang
张东方	Zhang Dongfang	李　喧	Li Xuan
陈一鸣	Chen Yiming	李锦江	Li Jinjiang
刘燕妮	Liu Yaini	尹德全	Yin Dequan
陶光明	Tao Guangming	冯　雷	Feng Lei
许晓锋	Xu Xiaofeng	王　娜	Wang Na
张　淼	Zhang Miao	朱　江	Zhu Jiang

冯　亮	Feng Liang	冯　慧	Feng Hui
王骁栋	Wang Xiaodong	吴　松	Wu Song
滕雪雷	Teng Xuelei	唐　佳	Tang Jia
马鎏学	Ma Liuxue	张　岩	Zhang Yan
唐文涛	Tang Wentao	黄丽媛	Huang Liyuan
张旭辉	Zhang Xuhui	王　刚	Wang Gang
沈　彦	Shen Yan		

光学工程/Optical Engineering

孙学诚	Sun Xuecheng	何世海	He Shihai
吴云飞	Wu Yunfei	卢意飞	Lu Yifei
顾培培	Gu Peipei	裴　斐	Pei Fei
段朝阳	Duan Chaoyang	刘　磊	Liu Lei
蔡清元	Cai Qingyuan	李振亚	Li Zhenya
邱永成	Qiu Yongcheng	李双柱	Li Shuangzhu
蒲海辉	Pu Haihui		
邢美术	Xing Meishu	赵二刚	Zhao Ergang

承担课题/Projects under Researching

序号	项目来源	课题名称（编号）	负责人	起止时间
1	973子项目	光参量放大过程中位相传递及其控制 2007CB815104-1	钱列加	2007.1-2009.12
2	863项目	高增益低噪声放大技术研究 2007AAXXX507	钱列加	2007.1-2007.12
3	863项目	宽频带激光三倍频新方案研究 2007AAXXX004	朱鹤元	2007.1-2007.12
4	863项目	高能短脉冲激光系统信噪比和色散控制技术研究2006AAXXX502	钱列加	2006.7-2007.6
5	基金重大项目	超高密度、高速光-磁混合数字信息存储研究 60490290	金庆原	2004.7-2008.6
6	基金重点项目	高强度飞秒激光的真空电子加速研究（实验部分工作） 10335030	钱列加	2004.1-2007.12
7	基金重点项目	新型纳米微结构光电子材料及微腔光子器件特性研究60638010	徐雷	2007.1-2010.12
8	基金面上项目	基于ECR- PLA等离子体的原位掺杂机理和应用 10475019	吴嘉达	2005.1-2007.12
9	基金面上项目	有机/无机复合材料热光效应增强机理及光波导器件制备研究60478005	刘丽英	2005.1-2007.12
10	基金面上项目	N-Ga共掺 P型ZnO薄膜的制备及其性质研究 60408003	孙剑	2005.1-2007.12
11	基金重点项目	1μm波段全系列宽带激光技术研究 60538010	范滇元	2006.1-2009.12
12	基金面上项目	超短脉冲信噪比测量方法研究10576009	朱鹤元	2006.1-2008.12
13	基金面上项目	共振激励研究全息聚合物分散液晶的相分离10574031	刘建华	2006.1-2008.12,
14	基金面上项目	DNA杂交的光学性质及其温度特性的椭圆偏振光谱分析研究60578047	李晶	2006.1-2008.12
15	基金面上项目	纳光子薄膜器件制备的原位光谱快速获取和特性分析研究60578046	王松有	2006.1-2008.12
16	基金面上项目	基于回廊耳语模式的非圆对称光学微谐振腔的发光特性及传感性能研究 10574032	刘丽英	2006.1-2008.12
17	基金面上项目	共轭聚合物固体激光材料及光特性研究 60578039	韦玮	2006.1-2008.12
18	基金重点项目	无机基有机杂化非线性光学材料的基础研究（分课题）50532030	刘丽英	2006.1-2009.12
19	基金面上项目	含氟稀土共轭聚合物波导放大器 60544001	韦玮	2005.1-2007.12

20	基金面上项目	介孔环境中掺杂液晶主-客体相互作用诱导光学非线性效应增强的原初动力学过程研究10474015	徐雷	2005.1-2007.12
21	基金杰出青年B项目	半导体表明的有机修饰与改性20428304	许国勤 彭波	2005.1-2007.12
22	基金面上项目	KDP晶体元件复合功能化学薄膜研究10476008	彭波	2005.1-2007.12
23	基金面上项目	新型量子信息载体材料90401027	彭波	2005.1-2007.12
24	基金面上项目	磁性复合有机半导体中的自旋注入、输运以及自旋相关效应 60501002	倪刚	2006.1-2008.12
25	基金面上项目	垂直高矫顽力记录介质的自旋超快过程研究60678008	金庆原	2007.1-2009.12
26	基金面上项目	巨磁电阻器件中极化电流激发的自旋波效应研究10604016	张宗芝	2007.1-2009.12
27	上海市重大项目	激光辅助混合磁存储的基础研究06DJ14007	金庆原	2006.11-2008.10
28	上海市光科技	高分辨率高可靠性的智能光网络监控系统研究05DZ22010	陈良尧	2005.10-2007.9
29	上海市重点	原位功能可控的复杂薄膜结构研究05JC14004	郑玉祥	2005.10-2007.9
30	上海市重点	可调谐高功率中红外激光光源及其应用研究05JC14005	范滇元	2005.10-2007.9
31	上海市重点	新构型量子点微腔激光器06JC14010	徐雷	2006.9-2008.9
32	浦江人才计划 团体项目	超高密度磁纪录材料与器件性能研究05PJ14016	张宗芝	2005.10-2007.10
33	上海市曙光计划	飞秒脉冲光参量放大的激光物理问题研究与新技术发展05SG02	钱列加	2006.1-2008.12
34	博士点基金	发光增强型多层硅纳米晶的制备及其发光特性20060246028	陆明	2007.1-2009.12
35	教育部新世纪优秀人才	快速光谱获取技术及其在环境科学中的应用NCET-06-0365	郑玉祥	2007.1-2009.12
36	上海市AM基金	硅表面高K金属氧化	吴嘉达	2007.12-2009.6

仪器设备/Facilities

序号	设备名称	型号	性能	用途
1	分子束外延设备(超高真空系统)	定制	极限真空: 1.5E-11 mbar	磁性超薄膜生长和性能测试
2	光刻机	SUSS MJB3 UV400	光刻基板最大尺寸：3英寸。样品台移动范围：X轴±3mm, Y轴3mm转角±3度。光刻分辨率0.6微米，套刻精度0.5微米，光强均匀性5%。汞灯350W。	用于各种器件图形的制备
3	扫描干涉显微镜（表面轮廓仪）	NV200HR	横向分辨率最大为0.22微米，纵向测量精度为0.1nm。	测表面粗糙度
4	掺钛蓝宝石飞秒激光器	MIRA BASIC	脉宽: 100fs； 输出功率: 振荡级 490mW 放大级 800mW OPA 30uj @ 606nm 调谐性:振荡级 750-850nm OPA 450-750nm	测量磁性薄膜材料的自旋超快动力学过程
5	锁模Nd:YAG激光器（皮秒）	PY61C-10	能量（with #9740Dye) 30mJ@1064nm, 15mJ@532nm, 5mJ@355nm, 3mJ@266nm; 脉宽40ps@1064 nm; 稳定性5%@1064nm; 7%@532 nm	皮秒脉冲光源
6	微波ECR实验装置+YAG激光器	自制	极限真空: 2 10-4Pa 工作气体: N2,O2, Ar, He, etc. 工作气压: 9 10-3Pa ~ 110-1Pa 微波频率: 2.45GHz 微波功率: 300-1000W 激光系统: 调Q-Nd: YAG (Continuum 公司) 波 长: 266nm, 355nm, 532nm, 1064nm 激光脉宽: 5ns 激光能量: 600 mJ/ pulse pu重复频率：1Hz ~10Hz	可以产生ECR等离子体、PLA等离子体ECR-PLA等离子体，用于ECR微波放电和脉冲激光烧蚀联合作用过程和ECR-PLA等离子体特性研究以及等离子体和激光束联合材料处理和制备技术探索和应用。
7	皮秒宽光谱扫描激光器	PL2143A	波长：220-2000nm, 脉宽：30ps, 重复频率 10Hz, 单脉冲能量 0.01-1mJ	材料的物性研究，微光学器件性能研究

8	多光子/共焦荧光显微镜	FV300-1X71/81	分辨率：1微米；激发波长：405和514nm;荧光探测波长：可见光	三维高分辨荧光图像和光谱分析
9	多功能扫描探针显微镜	XE-100	扫描范围100x100微米，精度0.1nm	测量固体表面形貌
10	高真空多靶磁控溅射仪	KJLC CMS-18	极限真空: 2E-8 mbar；6靶；共溅射；附带传样室。	磁性薄膜和器件的生长
11	ND:YFL激光器	EVOLUTLONXX	脉宽: 200ns 中心波长:527nm 输出功率: 5w	纳秒光源
12	飞秒激光器系统	SPIT FIRE 速率70	脉宽: 50fs 中心波长:800nm 输出功率: 振荡级 350mW 放大级 500mW	飞秒光源

获奖情况/Awards

BTW-1 激光装置研制

2007 年国家科技进步一等奖

完成人：彭瀚生等八人、**钱列加**（2007-J-24502-1-01-R09）

授权发明专利/Patents Approved

[1] ZL 200410025433.9；**一种对 Si 量子点掺杂的方法**；发明：方应翠，陆明，章壮健

[2] ZL 200510110456.4；**防水型宽带高增透薄膜及其制备方法**；发明：彭波，杨雨婷，蒋蕾，郭睿倩

[3] ZL 200510027779.7；**一种多窗口宽带增透 PS-SiO2 薄膜及其制备方法**；发明：彭波，蒋蕾， 郭睿倩

[4] ZL 200510027778.2；**一种多窗口宽带增透 PMMA- SiO2 薄膜及其制备方法**；发明：彭波，蒋蕾，郭睿倩

[5] ZL 200510028719.7；**一类含氟代苯基的聚苯乙烯撑及其应用**；发明：黄维，李盛彪，唐超，赵雷，朱旭辉，彭波，韦玮

[6] ZL 2004 1 0054019.0；**一种新型发光聚氨酯材料及其合成方法**；发明：黄维，张志坚， 王峰，赵雷，韦玮

[7] ZL 200510110256.9；**一种薄膜材料非平衡原位掺杂的制备方法**；吴嘉达、孙剑、凌浩

研究工作报告/Scientific Report

超快非线性光学的应用研究 / Applications of Ultrafast Quadratic Nonlinear Optics

成员：钱列加　朱鹤元　范滇元　　Group members: Qian Liejia, Zhu Heyuan, Fan Dianyuan

- ◆ 超快非线性光学的基础性研究 / Ultrafast quadratic nonlinear optics
- ◆ 非线性超快激光技术和测量方法 / Quadratic nonolinear technologies
- ◆ 超高功率短脉冲激光关键技术 / Elementary technologies for petawatt lasers

1.提出了新的宽带钕玻璃激光三倍频方案，它采用单块的分层部分氘化 KDP 作为混频晶体，可解决~4nm 带宽的高效率三倍频，适用于钕玻璃拍瓦系统直接输出的宽带啁啾脉冲激光。

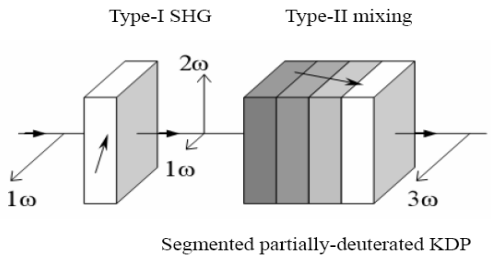


图 1. 新的宽带钕玻璃激光三倍频技术方案。单片式的分层部分氘化 KDP 作为混频晶体，具有不同氘化量的每一层对应着一定的位相匹配波长（具有可变设计性），使得不同波长的激光成份在不同氘化量的某一层晶体内发生混频，从而可满足宽带位相匹配的条件。

2. 研究了光参量放大（OPA）过程中位相传递的规律和影响因素及其对脉冲激光信噪比和光束质量的影响；提出并实验研究了阻断泵浦-信号位相传递的光参量放大新构型；形成了高能量、大口径 OPCPA 和 OPA 带宽激光放大系统的先进技术方案。

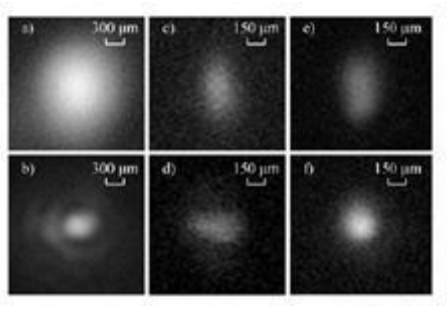


图 2. 光参量放大过程位相传递及控制的实验验证。受大口径元件光学质量、非线性效应等的影响，高能的泵浦脉冲激光不可能是衍射极限的，存在严重的位相畸变。泵浦光的位相畸变有可能通过 OPA 过程传递给被放大的信号光脉冲，从而影响脉冲激光信噪比和光束质量，并影响 OPCPA 的规模可扩性和相应的泵浦不稳定性带来的技术困难。

3. 运用创新的非线性光学方法，实验上成功测量了聚焦高斯光束轴上和近轴区域的相速度超光速分布。

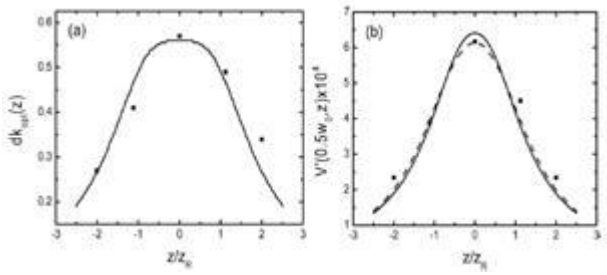


图 3. 聚焦高斯光束近轴（r=0.5W$_0$）处轴相速度沿传播方向（Z）变化的实验测量结果。聚焦光束的最高和频效率对应于一定的位相失配，隐含了相速度分布的信息。离轴聚焦高斯光束的最佳位相失配（a 图）与相速度分布存在着直接的对应关系，可提供高精度的相速度分布测量，图(b)显示了聚焦高斯光束近轴区域的相速度超光速分布。

课题组近期致力于发展自主创新的非线性超快激光技术,在我国的高功率激光工程方面起到重要作用，与中国工程物理研究院合作，获 2007 年度国家科技进步一等奖。今年度发表 SCIE 文章共 17 篇，授权了 1 项和申请了 1 项国家发明专利。

1. Broadband frequency tripling based on segmented partially-deuterated KDP crystals

We report a novel frequency tripler for efficient conversion of broadband high power laser pulses at 1 μm. Deuteration level can be used as a degree of freedom to alter the phase-matching wavelength of a partially deuterated KDP crystal. It has been shown that a segmented partially deuterated KDP crystal with discrete values of deuteration is capable of enhancing the acceptance bandwidth of frequency tripling. A five-segment design is presented, which is applicable to the efficient frequency tripling of Nd:glass petawatt laser pulses with a bandwidth of ~4-nm. The tolerances on the designing parameters are also evaluated.

2. Phase Transfer and Its Controlling in a Pair of Hybrid Seeded Optical Parametric Amplifiers.

Due to spatial walk-off and/or group-velocity mismatch among interacting waves, pump-to-signal phase transfer is inevitable in parametric interactions. By using a pair of optical parametric amplifiers (OPAs) seeded by the signal and idler respectively, we find that the phase of output signal can be restored regardless of the phase distortions on the pump source. The relaxation on the requirement of the pump quality in birefringent phase-matching configuration should be promising in developing high-energy OPAs or chirped pulse OPAs.

3. Measurement of the phase velocity distribution of a focused Gaussian beam by nonlinear approach.

To experimentally measure the phase velocity distribution of a focused Gaussian beam, we have proposed and demonstrated a novel approach based on quadratic nonlinear optics. In particular, we have designed and theoretically investigated the approach to measure the phase velocity by using off-axis second-harmonic generation, which pends a national patent. The approach is with a high measuring accuracy and suited for non-uniform phase distribution. In the experiments, we have measured on-axis and near axis distributions of phase velocity. The measurement is in a good agreement with the theoretical prediction, which suggests that there is a region with a velocity less than the standard light speed C for a focused Gaussian beam.

17 papers were published in SCI journals and 1 new technique was patented in 2006.

微光子学材料与器件 / Micro-Photonic Materials and Devices

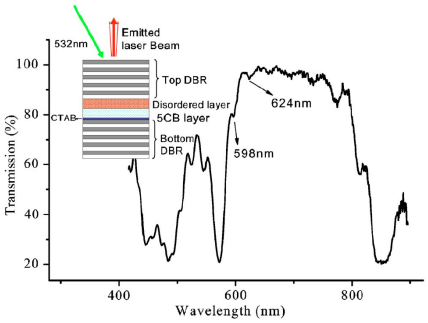
成员：徐雷　刘丽英　李毅刚　吴翔　　Group members：Xu Lei，Liu Liying，Li Yigang，Wu Xiang

研究方向：

- ◆ 微腔光子学/ Microcavity photonics
- ◆ 有机/无机复合材料光功能材料/ Organic/inorganic hybrid materials
- ◆ 新型光波导功能器件/ Fabrication and properties of novel optical waveguides
- ◆ 先进光子材料的非线性光学效应/ Nonlinear optics of advanced　photonic materials

1. 温度可调的染料掺杂液晶平面随机微腔激光及聚合物掺杂液晶随机激光

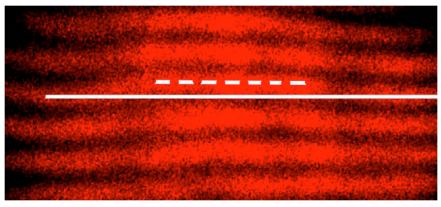
利用染料掺杂液晶制备了平面随机微腔激光。该微腔激光具有线宽窄(0.03 nm, 对应 Q >20000), 方向性好(1.4° 发散角)。通过改变温度可进行微腔激光输出波长的调谐。当温度从 27°C 到 34°C 变化时, 寻常光的输出波长可从 605.8 nm 到 608.5 nm 变化，非寻常光波长则从 631.3 nm 到 624.9 nm 变化。通过转移矩阵法对实验结果进行模拟，理论结果和实验结果符合得很好。另外，利用紫外光聚合的聚合物掺杂液晶作为随机激光的增益介质，在适当的紫外光曝光强度和时间的条件下，获得了高浓度分布的大小在 1μm 左右的液晶颗粒，从而利用了液晶颗粒的各向异性和可控性在聚合物波导中获得了温度可调和电场可调的随机激光出射。研究结果发表在 Optics Letters 和 IEEE Journal of Quantum Electronics 上。



含液晶层的平面随机微腔激光构型和器件的投射光谱

2. 飞秒光与连续光辐照诱导硫系玻璃的三阶光学非线性的变化

玻璃材料的光学三阶非线性效应具有飞秒量级的响应时间，因此在高速全光开关等领域具有潜在的巨大应用价值。硫系玻璃具有较大的非线性系数，比二氧化硅玻璃大两个数量级；它还有一些独特的特性：当受到某些光辐照时会有光致变暗的现象，同时会带来玻璃线性折射率的增大，从而带来三阶光学非线性的增加。我们利用飞秒脉冲光系统的振荡级输出，通过物镜聚焦于硫化砷(As_2S_3)玻璃中间，经横向区域扫描进行辐照；同时用波长为 579nm 的连续亚带隙光照射另外一块样品。通过吸收谱的测量，在两个样品中均观察到玻璃吸收边的平移，证明飞秒光与连续光辐照确实使样品产生了暗化。通过时间分辨的光克尔效应研究样品的三阶光学非线性，我们发现飞秒辐照区域的光克尔效应峰值比无辐照区域最大增大了 120%，换算成三阶非线性系数增大了 50%。而经连续光照后的区域三阶非线性系数降低，最大达 60%。该工作证明了飞秒光脉冲辐照是提高材料三阶光学非线性的有



飞秒光作用区域的折射率变化可通过干涉条纹的移动测量

效途径，可作为一种人工调控材料光学非线性的方法。研究结果发表在 Applied Physics Letters 上。

3. 高 Q 值有机/无机复合光学微腔激光器的制备以及光学性质的测量

有机/无机复合材料是有机和无机成分在纳米尺度下均匀混合而形成的一种新型材料。经过适当的设计，有机无机复合材料可兼具有机和无机两类材料的优点。在本文中，我们报道了染料（RhB）掺杂的有机/无机复合光学微腔制备及其光学性质测量的研究工作。我们用来制备微腔激光器的有机无机复合材料是通过溶胶－凝胶技术制备而成，并且可以利用紫外光刻工艺直接制备有机/无机复合材料器件。我们制备了圆形以及方形的回廊耳语模式（WGM）光学微腔，并在其上覆盖了一层很薄的 PMMA 薄膜。在微腔光学性质的测量中，我们将 Nd:YAG 皮秒激光的倍频光作为泵浦光，并通过一个聚焦透镜垂直地照射在微腔上。在微腔的侧面，用一个收集透镜收集出射的 WGM 激光，通过光纤束将光信号送到单色仪进行光谱分析。实验结果表明，PMMA 覆盖层有助于改善微腔侧壁的光滑度，从而提高 WGM 激光的 Q 值，降低激光的阈值。目前制备的有机/无机复合微腔激光器的 Q 值最高可达 12000，达到有机类微腔的最好水平。我们还通过选择性泵浦方式，激发方形微腔中的不同激光模式，以控制激光的方向性出射。研究结果将发表在 IEEE Journal of Quantum Electronics 上。

2007 年度本课题组完成国家自然科学基金项目 2 项。2007 年参与申请到上海市科委项目 1 项。2007 年度课题组在 Opt. Lett., Appl. Phys. Lett., IEEE J. Quantum Electron. 发表文章各一篇，和其他课题组合作参与发表 Angew. Chem. Int. Ed., Opt. Lett., Appl. Phys. Lett.文章各一篇；在国际会议上报告 7 次，其中会议邀请报告 3 次；在国内会议上报告 5 次；授权国家实用新型专利 2 项。

1. Liquid crystals based tunable high-Q directional random laser from a planar random microcavity and switchable random laser from dye-doped polymer dispersed liquid crystal waveguides

Temperature tunable directional laser emission from a dye doped liquid crystal based planar random cavity laser is presented. The optical pumped nematic liquid crystals infiltrated planar random microcavity produces an ultra-narrow linewidth (0.03 nm, corresponding to Q >20000), highly directional (1.4^{o} divergence angle) laser emission. By increasing the temperature from 27^{o}C to 34^{o}C, the wavelength of emitted polarized laser can be tuned between 605.8-608.5 (ordinary light) and 631.3-624.9nm (extraordinary light). A simulation result from transfer matrix method is also presented, which matches the experimental results well. In another work, a dye-doped polymer-dispersed liquid crystal (PDLC) film has been fabricated for random lasing action. In this PDLC film, the sizes of most liquid crystal (LC) droplets ranged from 200 to 500 nm. When the sample is optically pumped, ultrahigh (10 000) lasing modes and a collimated laser beam can be observed. The threshold of the random laser is shown to be 0.23 mJ cm2. Additionally, a 9.2-V m external electric field was applied to control the orientations of LC molecules, thereby obtaining a switchable random laser. Consequently, the linewidth, intensity, and polarization of the emitted random laser are controlled. The results were published in Optics Letters and IEEE Journal of Quantum Electronics.

2. Large and opposite changes of third order optical nonlinearities of chalcogenide glasses by femtosecond and continuous wave laser irradiation.

We report that the nonlinear refractive index (n_2) of As_2S_3 glass can be enhanced by

femtosecond (fs) laser irradiation, and be suppressed by a continuous wave (CW) laser irradiation, although both of fs laser and CW laser induce photodarkening in the glass. Photodarkening by a fs laser increases n_2 as high as 50 %, while irradiation by a sub-bandgap CW laser decreases n_2 to 60 % of its original value. The results give a way to manipulate third order optical nonlinearity of the photonic glasses. Mechanisms of the optical nonlinearity changes are discussed. The result was published in Applied Physics Letters.

3. High quality direct photo-patterned microdisk lasers with organic/inorganic hybrid materials

A sol-gel organic-inorganic hybrid microdisk-on-chip technique was proposed and used to fabricate 2-dimentional microdisks. The technique provides a simple and low cost method of fabricating high quality microlasers by direct photo-patterning. Whispering-gallery-mode laser emission from RhB-doped circular and square shaped microdisks has been observed. A thin polymer cladding on the microsdisk was found to obviously smooth the disk sidewall. As a result, a cavity quality factor (Q) as high as 12000 was achieved. The photo-sensitive organic/inorganic hybrid material provides a generic matrix for achieving lasing and other optical functions from microdisk devices. The result is to be published in IEEE Journal of Quantum Electronics.

In 2007, two NSFC projects were accomplished. A fund from Shanghai Commission of Science and Technology were jointly approved. Research results were published in Opt. Lett., Appl. Phys. Lett., IEEE J. Quantum Electron. Other achievements through joint collaborations were published in Angew. Chem. Int. Ed., Opt. Lett. and Appl. Phys. Lett. In addition, there are 7 presentations (3 are invited) in international conferences and symposiums, 5 presentations in domestic conferences. 2 China patents were licensed.

纳米混合存储及其相关物理问题研究 / Nano hybrid magnetic recording and related physics

成员：金庆原 张宗芝 马斌 Group Members: Jin Qingyuan Zhang Zongzhi, Ma Bin

进入 21 世纪，信息产业已经成为支柱产业之一，信息量的爆炸式增长要求信息存储密度迅速提高。为了适应记录密度的不断提高，磁记录的方式也从过去的纵向磁记录转向垂直磁记录，垂直磁记录技术将并且正在成为新一代数据存储的方式。磁记录密度的进一步提高，导致每一个位的尺寸以及晶粒尺寸迅速收缩，在室温下出现超顺磁。为了克服超顺磁瓶颈，必须提高介质的垂直磁各向异性，这使得磁记录写入头遇到前所未有的困难，因为传统写入磁头不能提供足够大的磁场来克服介质非常高的矫顽力。为此，人们提出了激光辅助磁写入、磁读出型光-磁混合存储的技术。该技术是一种新型的存储方式，它集光存储和磁存储的诸多优点于一身，能大大提高写入密度和读出分辨率，从而使存储密度大大提高，理论上可实现 10 Tbit/in^2 的超高记录密度，这使得激光辅助混合磁存储将成为更新一代信息存储的手段之一。我们主要围绕激光辅助混合磁记录的材料制备、记录的动态过程和实现、读出头性能和物理机制等方面进行了研究。

Information industry is one of the most important pillar industries. With the explosive increase of the information, recording density is required to be increased rapidly. In order to increase the magnetic recording density, the traditional longitudinal recording has been replaced by perpendicular recording, and perpendicular recording will and is becoming a new method of data storage. However, both the recording bits and grains shrink greatly in size with further increasing recording density, resulting in the superparamagnetic effect. In order to overcome the superparamagnetic limit, high anisotropy media materials should be used. The problem of using highly anisotropy materials is that the strength of the field produced by the traditional write head is not high enough to overcome the very large coercivity. One possibility to overcome the writing problem is to employ heat assisted magnetic recording (HAMR) technique. This new kind of hybrid optical-magnetic storage technique, which combines the advantages of both optical storage and magnetic storage, can greatly enhance the recording density and is expected to reach the density up to 10 Tbit/in^2. Our work mainly focuses on the HAMR-related meida materials fabrication, dynamic recording process, read head materials performance and their physical mechanism.

1. 超高密度纳米混合磁存储材料与系统(ultrahigh density nano hybrid magnetic recording materials and systems)：

在混合存储介质方面，研究工作集中在 FePt 有序合金薄膜的有序化和垂直取向方面，主要包括：（a）研究了在[FePt/SiO_2]多层膜结构中，FePt 有序合金薄膜的垂直取向机理；（b）在(200)Fe 表面织构生长 c 轴垂直取向的 FePt 薄膜，利用 Fe 膜的磁化翻转带动 FePt 实现反磁化，降低了薄膜的矫顽力，耦合薄膜的沿垂直方向的矫顽力在 4 kOe 左右；（c）研究了 Fe 覆盖层对 FePt 薄膜有序化的影响，发现当 Fe 层的厚度为 1.4 nm 左右时，薄膜的有序度和取向有明显的改善；（d）在硅基板上制备了 FePt/TbFeCo 薄膜，发现其反磁化过程随成分和温度有明显变化，并研究了其机理。

The research work regarding on the media materials mainly are focused on the ordering and perpendicular orientation of ordered FePt alloy film, including: (a) the perpendicular orientation mechanism of FePt in [FePt/SiO_2] multilayer structure; (b) Growth of FePt film with c-axis perpendicular to film plane deposited on top of (200) textured Fe. The soft Fe layer could help the magnetization reversal of FePt layer, leading to reduced coercivity. The coercivity in the

perpendicular direction of the coupled films is about 4 kOe; (c) The influence of Fe capping layer on the FePt ordering was studied. It is noted that the ordering and magnetization orientation are obviously improved when the Fe thickness is ~1.4 nm; (d) fabrication of FePt/TbFeCo film deposited on Si substrate, the magnetization process is found to be related to the composition and temperature, the mechanism is analysed.

光辅助磁记录、磁读出测试系统的搭建进入后续阶段。在聚焦兰光激光的辅助上，使用水平磁头对美国希捷公司提供的垂直样碟（矫顽力约 5 kOe）进行了动态写入和读出。测试中发现适当的条件下，利用激光辅助记录后的读出信号比没有激光辅助的要大，说明激光的作用已使磁性介质矫顽力下降，从而使得记录更加容易。从记录的 track profile 宽度和记录脉冲频率大致估算，目前动态记录的面密度已经超过 80 Gbit/in^2。

The building of HAMR measurement system is closing to the end. We have utilized the longitudinal read/write head to write and read dynamically on the sample disk (coercivity ~5 kOe) provided by America Seagate company, with the help of focused blue light beam. We found that under proper conditions, the laser-assisted readout signal is higher than the readout signal which has no laser assistance. It indicates that the laser has reduced the magnetic media coercivity, accordingly the recording becomes easier. The current dynamic recording areal density is estimated to be over 80 Gb/in^2, calculated from recording track profile width and pulse frequency.

2． 纳米自旋体系超快动力学(ultrafast spin dynamics of nano systems)

在激光辅助混合磁记录过程中，激光加热的热效应以及随后的能量传输，对于激光辅助下磁信息是否能够有效写入、写入后的信息稳定以及整个记录速度都起到关键的作用，而这个与记录材料的热磁特性和设计的附加热沉层（heat sink layer）很有关系。通过对记录材料的选择（当然要具有良好的温度特性）和膜层的结构设计，可以控制或改善其中的热量传输过程，以达到激光辅助混合磁记录的最佳要求。

During the laser assisted magnetic recording, the heat effect of the laser heating and the subsequent heat energy transfer play a key role on the laser-assisted efficient writing, the information stability after writing and the recording speed. These performance are dependent on the thermal and magnetic properties of recording materials and the designed heat sink layer. By properly choose the recording materials (with good temperature property) and design the film layer structure, we can manipulate and improve the heat transfer process, hence meet the optimal requirement of laser-assisted magnetic cording.

我们利用基于磁光克尔效应（MOKE）的 Pump-Probe 测量技术，对以下几种结构材料的自旋动力学弛豫过程进行了研究，重点集中在后面的恢复过程：1）具有面内各向异性的亚铁磁结构材料 TbFeCo（垂直各向异性的 TbFeCo 具有温度灵敏的磁性性质）；2）不同附加热沉底层及厚度的 FeCo 薄膜；3）硬磁/软磁材料组成的交换耦合复合结构 $L1_0$-FePt/CoFe。得到的结果已经整理成文，投出和即将投出 3 篇文章。

We have studied the spin dynamic relaxation process, with emphases on the later relaxation process for materials with following different structures, by employing MOKE-based pump-probe technique: (1) ferromagnetic TbFeCo with in-plane anisotropy (TbFeCo with perpendicular anisotropy has temperature-sensitive magnetic properties); (2) FeCo films with different kinds and thicknesses of heat sink layers; (3) exchange-coupled hard/soft $L1_0$-FePt/CoFe composite system. 3 papers have been submitted regarding these results.

对于 TbFeCo 薄膜，发现自旋体系在退磁后的弛豫恢复过程比较长（达几百皮秒），图 1

给出了不同 Tb 含量 TbFeCo 薄膜的磁化强度动态弛豫过程。考虑到材料具有较大的磁致伸缩效应，我们认为：由于在激光加热时的退磁，导致较大的晶格伸缩，与周围没有激光照射区域晶格常数相差较大，故而影响了热能的及时传输，这样磁性恢复的过程相对较长。如果这个分析正确，这将给通常自旋体系恢复过程，提供了一个新现象。

It was noted that the spin recovery time of the TbFeCo films is relative longer (up to several hundred ps), figure 1 shows the magnetization relaxation versus delay time for TbFeCo films with various Tb conents. Considering the large magnetostriction effect of the material, we can explain the slow recovery as follows: the demagnetization caused by laser heating can generate severe lattice shrinkage, which restricted the fast transfer of the heat energy. Therefore the magnetization recovery process is quite long. If the opinion is correct, it offers a new phenomenon for the magnetization recovery process of spin systems.

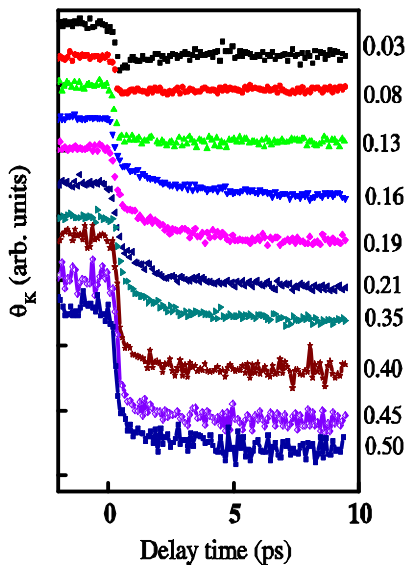


图 1 TbFeCo 的磁驰豫过程

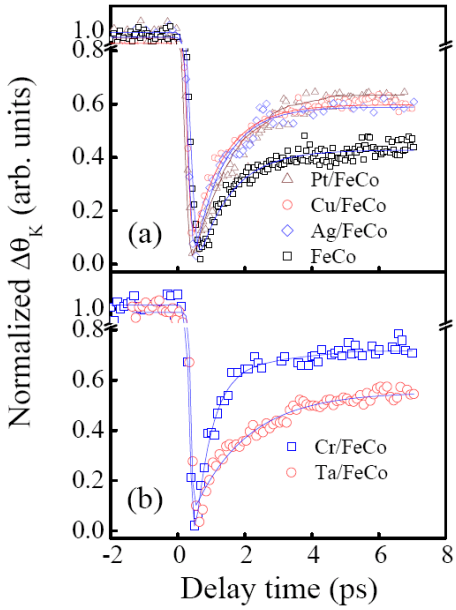


图 2 不同导热层材料对磁恢复的影响

底层 Ag, Cu, Pt, Ta, Cr 下的磁性恢复过程的系统研究，发现晶体结构和晶格常数的匹配对能量传输比较有利，如上图 2 所示。在几十飞秒时间区域，底层的热传导系数和厚度并不是决定恢复快慢的主要原因。

Systematic studies have been performed on the magnetization recovery process for FeCos film with Ag, Cu, Pt, Ta, or Cr underlayers, some results are shown in Fig.2. It is found that the lattice structure and lattice constant matching are very advantageous to the heat transfer. The thermal conductivity coefficient and thickness of the underlayers are not the major factor to determine the recovery speed with the time range of several tens of fs.

对于 FePt/CoFe，发现激光作用可以降低或去除层之间的铁磁交换耦合，使得自旋动态过程表现为两部分独立的行为。随着延迟的增加，这种退耦合的状态逐渐恢复耦合，再度表现为一个整体自旋翻转的行为，如图 3 所示。这说明，我们可以设置合适结构，动态控制耦合状态，从而达到调整自旋翻转行为和自旋恢复过程的目的。

The laser heating can reduce and even remove the ferromagnetic exchange coupling between FePt and CoFe, and the temporal magnetization loops exhibit two

independent switching behaviors. With the increase of delay time, The re-building of the exchange coupling results in again a single-layer-like switching behavior, see Fig. 3. The effect of the laser pump fluences on the dynamic process provides a possible way for ultrafast manipulation of the interfacial exchange coupling, and hence we can realize the purpose to tune the magnetization switching behavior and spin recovery process by designing proper composite structures.

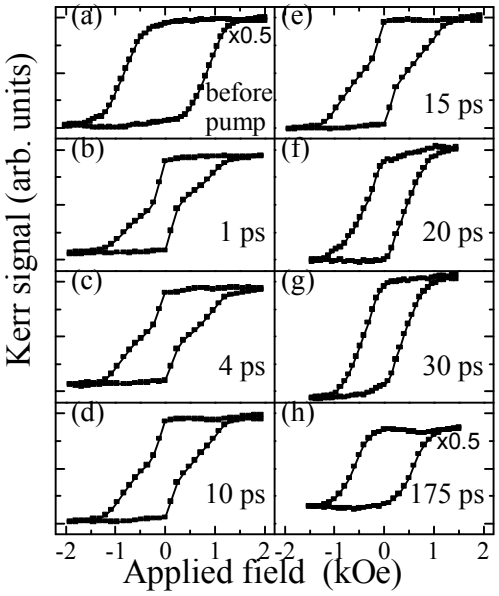


图 3 飞秒激光 pump 前 (a)，后 (b-h)FePt/CoFe 双层耦合膜的 MOKE 回线随延迟时间的变化过程

3. 自旋电子学材料和微磁学模拟
(spintronics materials and micromagnetic simulation)

在自旋电子学材料方面，(1) 制备了以硬磁性 $L1_0$-FePt/CoFe， FePt/Ru/CoFe，FePt/CoFe/Ru/CoFe 为磁性参考层的自旋阀材料，获得了比较高 GMR 信号(7%)和 高的交换场（近 2000 Oe），同时研究了热稳定性及降低自由层矫顽力的方法.相关工作发表在 J. Appl. Phys 和 IEEE Tran. Magn 杂志上。(2) 研制了具有垂直各向异性磁性的 Co/Ni 多层膜和垂直自旋阀，所得到的 GMR 信号是目前文献报道中最高的（图 4(a,b)），且观察到比较高的垂直交换偏置场和双偏置现象。

About the spintronics materials, (1) we have prepared spin valves with $L1_0$-FePt/CoFe，FePt/Ru/CoFe， FePt/CoFe/Ru/CoFe as reference layers, high GMR signal of 7% and exchange field (~2000 Oe) were obtained. Moreover, we also studied the samples thermal stability and the ways to reduce the free layer coercivity. The results were published in journal of J. Appl. Phys 和 IEEE Tran. Magn; (2) we have fabricated and investigated the Co/Ni multilayer and spin valves with perpendicular anisotropy, the GMR signal is higher than 7%（see Fig.4 (a,b)）. We also studied the perpendicular the exchange bias and double shift in the hysteresis loops.

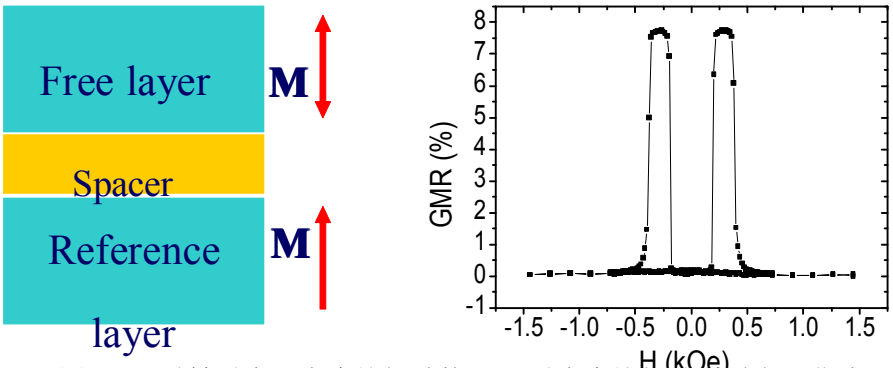


图 4 (a) 易轴垂直取向自旋阀结构, (b) 垂直自旋阀的巨磁电阻曲线

在模拟计算方面，(1) 采用自主开发的微磁学模拟程序理论计算了低电阻隧道结中自旋转移矩效应引起的自由层磁化翻转效应。我们提出了一种隧穿和金属传导共存的导电模型，研究发现临界翻转电流与纳米金属导电通道的位置、尺寸密切相关。随金属通道尺寸的增加，临界翻转电流和翻转时间均降低。这种模型不仅能合理解释隧道结中翻转电流比较低的现象，而且为自旋转移矩器件的实用化提供了合理的设计方案。相关工作发表在 Appl. Phys. Lett 等杂志上。(2) 研究了垂直磁化材料中的电流驱动的磁化翻转效应，并设计了一种垂直硬磁和软磁纳米核共存的结构，发现软磁纳米核磁矩的转动能够帮助硬磁相的转动，从而有利于磁化矢量的快速翻转和降低临界电流，如图 5(a,b)所示。这部分工作已发表于 Appl. Phys. Lett.。

About the simulation work, (1) we have studied the spin-torque-driven mangetization switching in low resistance magnetic tunnel junctions. We proposed a conductive model of tunnelling channel and metallic nano conduction channel coexistence in the tunnel barrier. It is found that the critical switching current is related to the nanochannel position and size. With increasing nanochannel size, the critical switching current and switching time decrease. This model not only can reasonably the experimentally observed low critical current density in magnetic tunnel junctions, but also supply a reasonable design frame in practical spin-transfer-switched devices. Parts of results were published in Appl. Phys. Lett. (2) Spin-transfer-driven switching was investigated in perpendicular spin valve nanopillars with a free layer structure which contains two in-film-plane regions: a main perpendicularly magnetized hard region and a soft nanocore with intrinsic in-plane anisotropy. The initial magnetization rotation of nanocore to in-plane direction generates driving force acting on the hard region via exchange coupling, which helps the magnetization rotation of the hard reqion, leading to considerable reduction in both critical current and switching time, as shown in Fig.5(a,b). The work has been published in Appl. Phys. Lett.

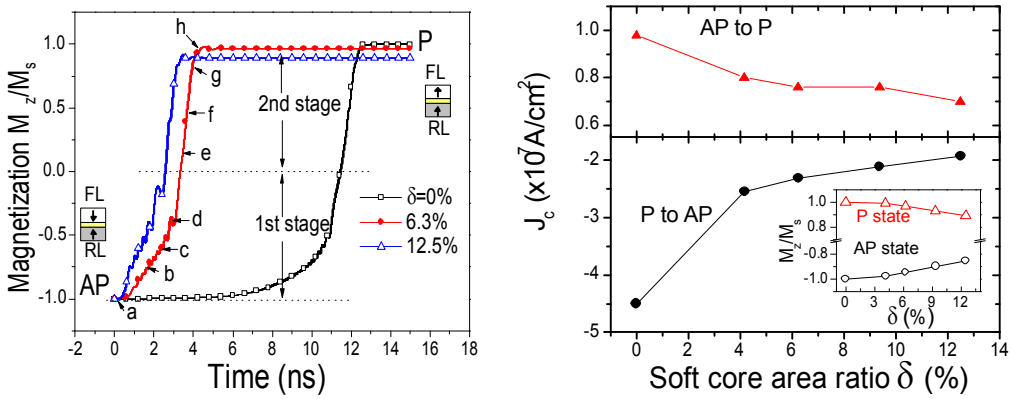


图 5(a) 自由层磁矩翻转时间, (b)和临界翻转电流与软磁纳米核的关系

4. 纳米存储材料的自组织生长

在电化学模板制备纳米材料方面取得重要进展，在制备的六角对称具有良好结构、整齐规则的 Al_2O_3 多孔模板上，发现在氧化阻挡层（barrier layer）存在枝状结构，尺寸在几个纳米尺寸，此结构对于制备纳米尺度的量子受限结构材料具有重要用途。这部分结果发表在纳米材料的重要期刊 Nanotechnology 上（见图 6），一位审稿人评价说我们这个工作提供了一个新颖的制备技术，纳米科学学术界将对此有兴趣；另一位审稿人指出氧化铝模板已经发展成为纳米科学非常通用的手段，但从细节上讲还远远没有被搞清楚，这篇工作帮助弄清楚了

这些过程，特别是对于底部的多孔结构。

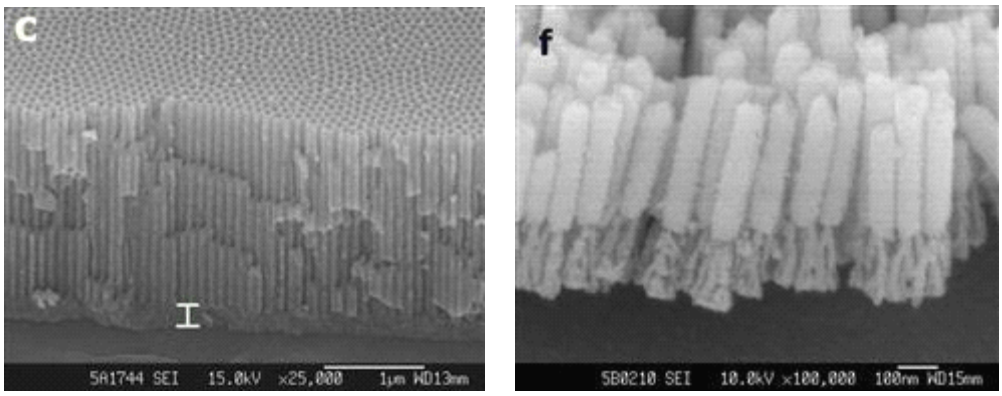


Fig. 6　氧化铝模板多孔结构和枝状 FeNi 纳米结构

本年度发表 SCI 论文 9 篇，完成译著“磁记录物理”一本。新获国家基金委面上项目 2 项，上海市浦江人才计划团体项目顺利结题。

译著：

磁记录理论---车晓东，廖嘉霖、金庆原等译，复旦大学出版社，2007。（原著H. Neal Bertram, Theory of Magnetic Recording, Cambridge University Press, 1994）

凝聚态光学性质与光谱学研究进展 / The Progresses on the Study of Optical Properties of Condensed Matters and Spectroscopy

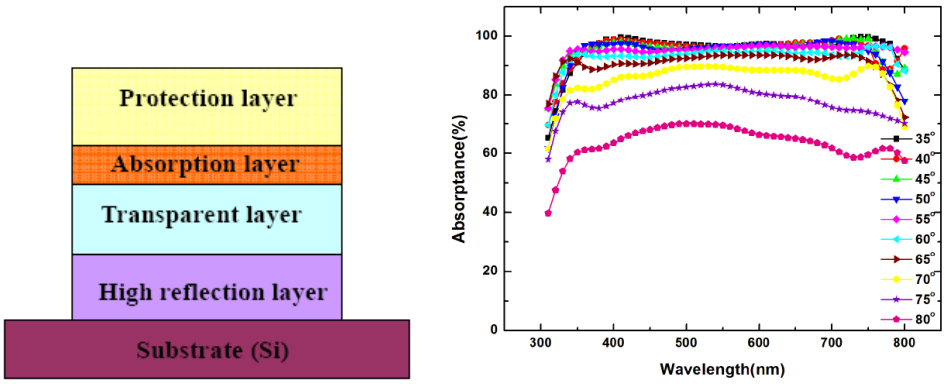
成员：陈良尧 郑玉祥 王松有
李 晶 张荣君

Group Members: Chen Liangyao，Zheng Yuxiang, Wang Songyou, Li Jing, Zhang Rongjun

◆凝聚态光谱学和固体的光学性质

◆spectroscopy of condensed matter and optical properties of solid state materials

1. 高效率光热转换太阳能薄膜研究：研究和制备了具有很高光热转换效率的太阳能薄膜材料，采用多层金属/介质薄膜结构，在 400-1000nm 太阳光谱区，光吸收效率高于 95%，在正入射和 600K 条件下，热辐射系数约为 0.063。这种无机太阳能光热转换薄膜结构具有制备工艺简单、效率高、成本低、寿命长等优点，在绿色太阳能器件领域将具有很好的应用前景。



(a) (b)

Fig.1 (a) 四层太阳能-热能转换薄膜结构与特性： (b) 不同入射角下测量的吸收谱

We have designed and achieved a multilayer structure which has high solar absorption efficiency (>95%) in the 400-1000nm wavelength region and low thermal emittance (ε=0.063 at 600K and normal incidence condition). The materials used in application are cost-effective with relatively simple procedure for production and quality control to show the potential application of the structure in the solar energy field.

2. 研制完成具有光谱实时监控功能的光电子功能薄膜材料和器件制备系统原型样机 1 台，具有原位光谱特性分析功能，将能够在薄膜样品生长过程中对透射或反射光谱特性进行实时监控，不仅能获得薄膜的厚度信息，还能获得更多关于光强、光谱带宽和线型等信息，从而为高性能薄膜器件的光谱特性原位监控以及高效率制备创造了条件。系统采用自行研制的新型红外光谱获取和分析系统。为了能同时满足宽波长区、高分辨率和快速光谱测量的要求，在研究中采用了一个由 5 块子光栅组成的集成光栅系统和 5 个 InGaAs 红外线阵探测器，组成一个完整的装置，用于 1450-1650nm 工作波长区。由于设计中避免了机械式的扫描结构，系统显示出长时间工作稳定性、数据读取的高可靠性和快速读取数据等优点。经校准，系统的光谱分辨率为 0.08nm，最快全光谱获取时间小于 40ms(>5nm/ms)。实验光谱系统具有工作波长区宽、采集数据速度快和长期工作可靠性高等优点。本实验室系统可用于高性能光电子功能薄膜的原位光谱特性监控生长，包括对由四分之一波长和非四分之一波长光学厚度组成的混合薄膜结构的复杂特性进行实时监控，实现具有亚纳米光谱分辨的高性能光电子器件

的可靠制备。在完成系统研制基础上，设计了一个 Ta_2O_5/SiO_2 窄带通滤波膜系 $S(HL)^7HH(LH)^7A$，S 表示基底层，折射率为 1.5，A 表示入射层，折射率为 1.0，H 代表 Ta_2O_5 层，厚度均为 183.8nm，L 代表 SiO_2 层，厚度均为 256.8nm。中心波长处透过率高于 93%，带宽约 8.5nm。

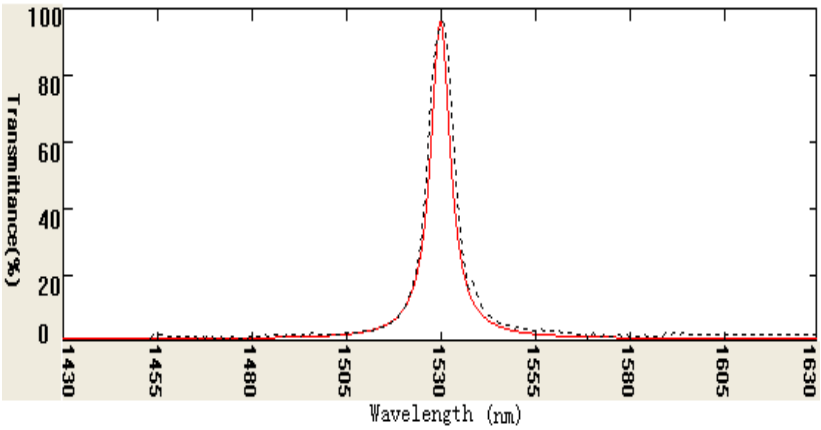


Fig.2. Narrow bandpass filter: Theoretical data(full curve) experimental data at the end of deposited process(dotted curve)

We have developed a thin-film coating system with real time broadband optical monitoring (BOM) method. This system is applicable to analyze optical properties of thin film materials in situ and can also monitor the deposition process of the thin film sample simultaneously. Since the monitoring system can acquire not only the thickness information of the thin film but also the light intensity, the bandwidth of spectra, and the line-shape information etc, it becomes a platform for making high quality optical thin films efficiently under the monitoring of BOM in situ. The system uses a new type of home-made infrared spectral analyzer. To meet the demand of broadband, high spectral resolution and high acquisition speed for the spectra, the system was made with five InGaAs infrared line-array detectors and an integrated grating consisting of five subgratings and formed a spectral analyzer covering wavelength range of 1450–1650 nm. Without any mechanical scanning and moving parts, the full real-time spectral image of the sample can be obtained rapidly and accurately in less than 40 ms and with a spectral resolution of about 0.08 nm. The spectrometer system has advantage of broadband of wavelength, high speed of data acquisition and high stability over long-term running, and it can be used to monitor the deposition process in situ for coating the optoelectronics functional film of high performance, including thin films of quarter wavelength and non quarter wavelength and realize manufacturing of sub-wavelength devices. On the basis of the development of the thin film coating system with BOM, a narrow bandpass filter with structure "$S(HL)^5HH(LH)^5A$" has been made with the system, where S stands for the substrate having a refractive index of 1.5, A stands for the incidence layer having a refractive index of 1.0, H means the Ta_2O_5 layer having a higher refractive index. The thickness of the H layer is 178nm. L means the SiO_2 layer having a lower refractive index. The thickness of L layer is 256.8nm. The bandwidth of the filter is found to be 8.5nm, and the transmittance is about 93% at the central wavelength.

3. 磁控溅射法制备铝掺杂 $Ge_2Sb_2Te_5$ 薄膜相变特性研究：用磁控溅射系统在 Si(100)衬底上

共溅制备了铝掺杂 $Ge_2Sb_2Te_5$ 薄膜。用 X 射线光电子能谱测定了铝的组分。运用 X 射线衍射法及可控温的 UVISEL™ 型椭偏仪测量分析了铝掺杂对样品薄膜相变特性的影响。结果表明，随着铝掺杂量的增加，Al_xGST 样品薄膜的结晶温度升高，其面心立方相具有更高的温度稳定性。薄膜的反射率对比度显著提高，有助于提高用于相变存储的信噪比。

Phase change characteristics of aluminum doped $Ge_2Sb_2Te_5$ films prepared by magnetron sputtering: Aluminum-doped $Ge_2Sb_2Te_5$ (Al_xGST) films were deposited on Si(100) substrates by co-magnetron sputtering system. The Aluminum concentrations in these films are determined by X-ray photoelectron spectroscopy (XPS). The influence of Al doping upon phase change characteristics of these Al_xGST alloy films has been investigated by X-ray diffraction (XRD) and a temperature-regulable UVISEL™ typed spectroscopic ellipsometry (TRSE). With the augment of Al doping concentration, the crystalline temperatures of Al_xGST films went up while annealing, and the face-centered-cubic (fcc) phase had high thermal stability. The reflectivity contrast of the films increases obviously, which is effective to improve the signal to noise ratio (SNR) for optical phase-change storage.

4. 纯化学配比的氧化锆薄膜实现可重复的单极电阻开关效应：研究了基于完全化学计量比 ZrO_2 薄膜作为非易失性存储器的电阻开关特性。经过研究发现，这种 Al/ZrO_2/Al 结构的器件表现出可靠的、可重复开关性能，并有较大的高阻/低阻比（2×10^3）。在低工作电压范围内，由于在工作单元中形成了可导通的导电细丝（filamentary），器件呈现出欧姆电阻特性；在高工作电压范围内（$V_{reset}<V<V_{set}$），器件的导电机制主要是受到 Schottky 效应的影响。Al/ZrO_2/Al 信息功能薄膜能够产生稳定的开关效应，是由伴随大电流产生的焦耳热和 Al 与 ZrO_2 薄膜的自发反应造成的。

Reproducible unipolar resistance switching in stoichiometric ZrO_2 films: The resistance switching characteristics of stoichiometric ZrO_2 film were investigated for nonvolatile memory. The Al/ZrO_2/Al device presents reliable and reproducible switching behaviors. The on/off ratio of two stable states is larger than 2×10^3. It is suggested that the current-voltage characteristics are governed by the Schottky conduction mechanism in high voltage region, while the filament conduction is suggested in low voltage region. The switching process is explained in terms of the spontaneous reversible reaction between electrode and ZrO_2 films with the contribution of Joule heating effect by the external current.

5. $Al_{1-x}Si_x$ 液态合金的结构和动力学性质的第一性原理分子动力学研究：采用基于第一性原理的分子动力学计算方法，研究了 $Al_{1-x}Si_x$ (x =0.0, 0.2, 0.4, 0.6, 0.8)不同组分的液态合金在 1573K 温度下的结构和动力学性质。对不同组分下 $Al_{1-x}Si_x$ 合金的结构因子，对关联函数，以及扩散常数进行了理论计算。计算结果表明，组分对液态 $Al_{1-x}Si_x$ 的结构和动力学性质有着明显的影响。局域结构主要是由四面体和变形的的二十面体构成。以 Si 为中心的团簇的原子数小于以 Al 为中心团簇的原子数。计算得到的电子态密度表明液态 $Al_{1-x}Si_x$ 具有金属性。$Al_{1-x}Si_x$ 中 Al、Si 的扩散常数随着 Si 比例的增大而增大。

Structure and dynamics of liquid $Al_{1-x}Si_x$ alloys by *Ab initio* molecular dynamics Simulations：First-principles molecular dynamics simulations are performed to study the structure and dynamics of liquid $Al_{1-x}Si_x$ (x =0.0, 0.2, 0.4, 0.6, 0.8) at the temperature of 1573 K. The

composition dependence of static structure factors, pair correlation functions, and diffusion constants are investigated. We found that the structure and dynamics of the liquid $Al_{1-x}Si_x$ alloys are strongly dependent on the compositions. The local structure is dominated by tetrahedral and some distorted icosahedral structure. Si-centered clusters are found to be smaller than the Al-centered clusters in the liquid. The calculated electronic density of states shows that all the $Al_{1-x}Si_x$ liquids are metallic. The diffusion coefficients of Al and Si in liquid $Al_{1-x}Si_x$ alloys are found to increase as the Si concentration is increased.

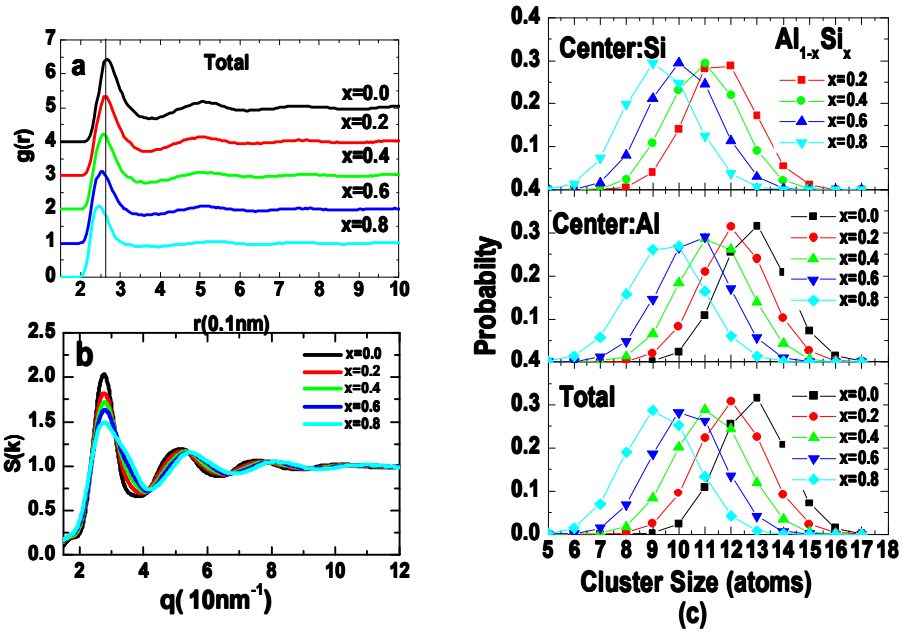


Fig. 5(a) Total pair-correlation function; (b)Total structure factors; (c)Clusters size distribution functions of liquid $Al_{1-x}Si_x$ at 1573 K

6. 多态光存储材料 $Ge_2Sb_2Te_5$ 光学性质的理论和实验研究：$Ge_2Sb_2Te_5$ (GST) 是一种被广泛使用的相变存储材料，它可以实现晶态与非晶态之间的可逆转变。实验上已经证实 GST 材料不仅可以实现晶态立方相与非晶态相间的可逆转变，在一定条件下，还可以实现立方相和六角相之间的可逆相变。因此，如果对非晶态相、立方相、六角相下 GST 材料性质上的差异加以利用，就可以实现多态存储，并大幅提高存储密度。从理论、实验两方面研究了晶态 GST 的电子结构和光学性质。研究结果表明，立方相 GST 具有半导体导电特性，而六角相 GST 导电性更强。在 400nm 至 700nm 的光谱范围内，两种晶态相下的 GST 反射率差异大约为 8%。利用这种反射率之间的差异可以实现不同晶态之间的信息存储。

Theoretical and experimental investigations of optical properties of $Ge_2Sb_2Te_5$ for the multi-state optical data storage： $Ge_2Sb_2Te_5$ (GST) is widely used as an excellent phase change material due to its reversible transition between crystal and amorphous states. It was demonstrated that GST can not only be transformed reversibly between amorphous and cubic but also be transformed reversibly between cubic and hexagonal states under certain conditions. Thus, if we could take advantage of the differences among the amorphous, the cubic, and the hexagonal state, GST would be used as the multi-state storage material and its storage density would be improved remarkably. In this study, we investigate the electronic and optical properties of the crystal GST

by both the ab-initio and the experimental study. Results show that the cubic GST is semi-conductive while the hexagonal GST may exhibits much higher conductivity. The reflectivity contrast of the two crystal states is above 8% in the range from 400nm to 700nm, rendering GST the potential applications in the multi-state storage.

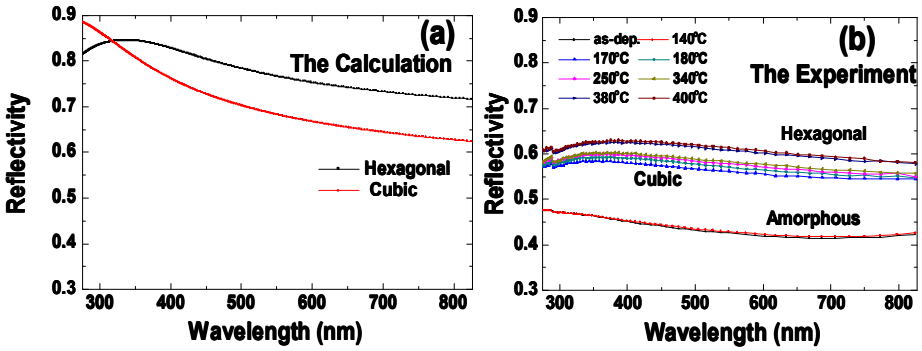
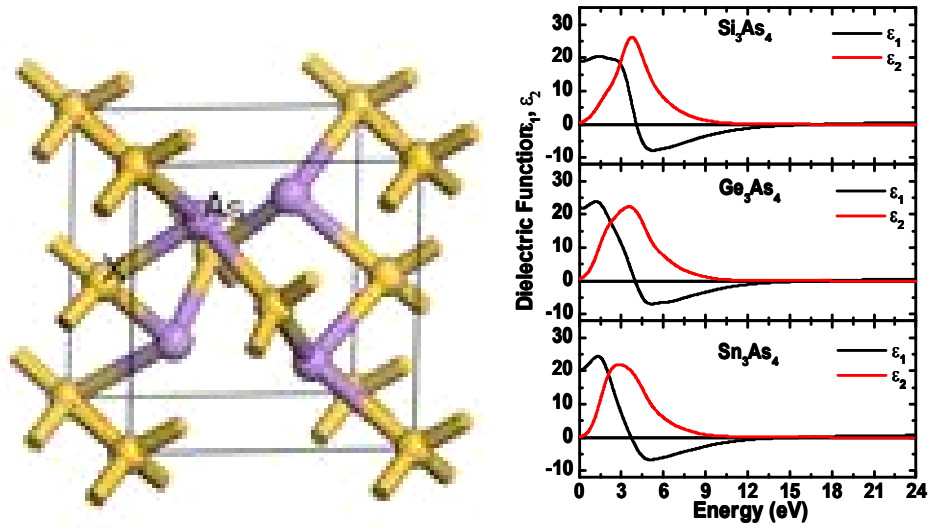


Fig.6. (a) The reflectivity of the cubic and the hexagonal GST by the calculations. (b) The experimental reflectivity of the GST films as-deposited and annealed at different temperatures.

7. ⅣA 族砷化物 X_3As_4 光学性质的第一性原理研究： 基于第一性原理，对赝立方结构 IVA 族砷化物 X_3As_4（X=Si、Ge、Sn）的电子结构、光学性质进行了理论研究。结果表明：X_3As_4 具有间接带隙型能带结构；Si_3As_4、Ge_3As_4、Sn_3As_4 的间接带隙能分别为 0.1eV，0.25eV，0.54eV。根据费米面附近的态密度分布，IVA 族元素的 np 电子轨道与 As 的 4p 电子轨道发生杂化；X-As 的结合具有很强的共价特性。在光学性质方面，计算了 X3As4 的光学常数 $\varepsilon_1,\varepsilon_2$、能量损失谱等。X3As4 在可见光波长范围内有明显吸收，这与 p 电子在费米面附近的带间跃迁行为有关。

First-principles Study of Optical Properties of Group IVA Arsenides X_3As_4: The electronic and optical properties of group IVA arsenides X_3As_4 (X= Si、Ge、Sn) with pseudocubic structure are theoretically studied by using a first-principles method. The electronic properties of X_3As_4 are characterized by an indirect band gap of 0.1eV，0.25eV，0.54eV for Si_3As_4, Ge_3As_4 and Sn_3As_4, respectively. Calculated partial density of states near Fermi level suggests hybridization for X-np and As-4p states, indicating a strong covalent nature of X-As bonding. Dielectric function, energy loss function are calculated to investigate the optical properties of X_3As_4. It is found that X_3As_4 have significant optical absorption within the visible light region, which is related to the interband transitions of p electrons near Fermi level.

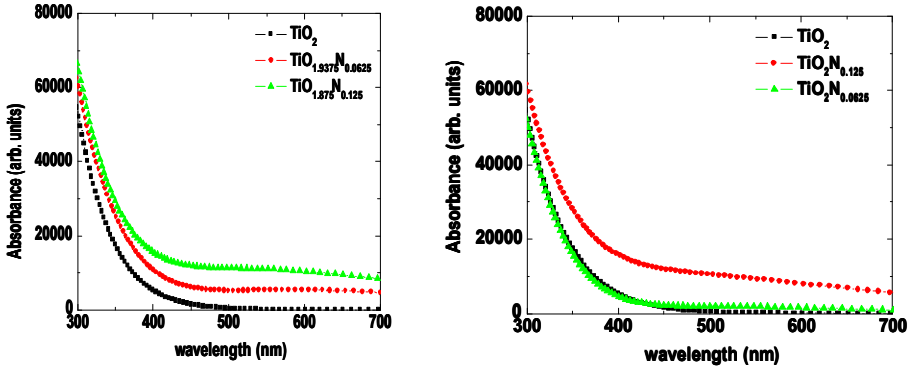


(a) (b)

Fig. 7. (a)The ball-stick model;(b) The calculated dielectric functions of the pseudocubic X_3As_4

8. 氮掺杂锐钛矿型二氧化钛中点缺陷的理论研究: 采用基于第一性原理的广义梯度近似下的平面波赝势方法，对具有点缺陷的二氧化钛电子结构和光学性质进行了理论计算。研究了两种点缺陷，氮取代以及氮填隙，对掺氮二氧化钛可见光化机制的影响。研究结果表明，取代氮的 2p 电子态分布在价带顶部与氧 2p 电子态发生重叠，使价带略有展宽。氮的取代掺杂使二氧化钛在 400nm 至 700nm 光谱范围内的光吸收有所增强。氮填隙掺杂对二氧化钛光学性质的影响与杂质氮与周围氧之间的相互作用有关。氮与氧之间的成键作用在上价带顶部和底部附近引入了一系列占据的局域电子态。电子从这些电子态的跃迁增强了二氧化钛对可见光的吸收。

Theoretical study on the point defects in N-doped anatase TiO_2：First-principles calculations for the electronic and optical properties of titanium dioxide (TiO_2) with point defects are performed by using a plane wave pseudopotential method in the framework of density functional theory and generalized gradient approximation. The point defects, substitutional and interstitial nitrogen, in anatase TiO_2 are investigated to understand the origin of the visible light sensitivity of nitrogen (N)-doped TiO_2. The results show that the bands originated from substitutional N 2p states appear above the top of the valence bands. The overlap of the N 2p and O 2p states results in a small broadening of the valence bands. The optical absorption through the range between 400 and 700 nm is enhanced by the substitutional N impurities. The effect of interstitial N on the electronic and optical properties of TiO_2 is dependent on the interaction between the nitrogen dopants and surrounding oxygen. The bonding between N and O introduces a series of localized occupied states under and above the upper valence bands, and the electron transitions from these states improve the visible light absorption of TiO_2.



(a) (b)

Fig. 8. Calculated absorbance. (a) TiO_2, $TiO_{1.9375}N_{0.0625}$ and $TiO_{1.875}N_{0.125}$.(b) TiO_2, $TiO_2N_{0.0625}$ and $TiO_2N_{0.125}$.

9. 利用矢量衍射理论结合光学矩阵法的理论研究了任意形状光波在各种多层膜或超晶格信息存储结构中（例如磁光、相变、热辅助磁存储）的传播和与材料相互作用的问题。这种方法可以给出任意分布光束在信息存储多层膜中传播的全部重要参数，如复磁光克尔系数（包括克尔旋转角、克尔椭偏率）、磁光信号、反射率、透射率、电场分布、磁场分布、焦耳热损失分布等。从中得到的理论数据或结果可以有效地开展光学多层膜器件的设计及优化。

Vector diffraction theory and the optical matrix method were used to study the propagation properties and interaction with the media for a light beam with arbitrary profile travelling in multilayer thin film structure or super-lattice structure, for example, in information storage structure s(Magneto-optical storage、phase change storage、heat assisted magnetic recording etc.). This method can give all the parameters regarding the propagation of a light beam with arbitrary profile in thin film stack, such as the optical and magneto-optical responses, the electric and magnetic field distributions, and the Joule loss profiles. The results can be used to the design and optimization of optical multilayer thin film devices.

10．研究了在 SiO_2 介质中制备的钠米硅，用椭偏光谱的方法测量了这种复合薄膜的宏观光学性质，并用有效介质(EMA)模型，结合 F-B 色散关系，拟合得出硅钠米晶复合薄膜的复折射率与介电函数等光学性质，讨论了这些光学性质同薄膜中硅钠米晶的关系。

In this work, a series of SiO_x/SiO_2 superlattices were prepared， by using reactive evaporation， with different thicknesses of the SiO_x layers. After being annealed at 1100℃, composite thin films with the nano-crystals of silicon (nc-Si) embedded in the SiO_2 layers were formed. The optical properties of the films were measured by using the spectroscopic ellipsometric (SE) method in the photon energy range from 1.5 to 4.5 eV at three different incidence angles of 65°, 70°, and 75°.In terms of the ellipsometric data, the effective medium approximation (EMA) with the four-parameter Lorentz oscillator model was used to fit the spectra and to extract the optical dispersion of the nc-Si particles. We found that the dielectric functions of the composite films strongly depended on the volume fraction of nc-Si and the constant of the SiO_2 layers, which changed with the composition in the investigated spectrum range.

11.光在薄膜结构中传输的空间干涉效应研究：光在薄膜材料中传播时发生的干涉不仅依赖于由微结构造成的振幅和位相的改变，而且依赖传播的空间位置。在研究中，采用变波长和变入射角的椭圆偏振光谱方法，设计了不同厚度的 SiO_2 薄膜结构，测量了椭偏参数随位相差变化的规律，给出了光频电磁波在薄膜结构中传播时的空间干涉模型，对经典椭圆偏振光谱测量模型进行了修正，并用于实验结果的分析，获得了新模型与实验数据很好吻合的结果。所给出的考虑空间干涉效应的光学薄膜公式将可用于周期和非周期光子薄膜材料和器件设计、分析和性能测试，将有助于提高光电子器件的性能，促进应用。

We have studied the spatial effect on the interference of the light propagated in the film structure.The light interference has been analyzed for the film structure by considering that the spatial separation exists for the two neighboring light beams to be interfered in the space. There is significant difference occurred between the situations of the interference with or without consideration of the spatial effect, especially around the region where the phase delay $\delta = \pi$ and 2π by taking example of the one-layered SiO_2/Si structure. It will be safe to extract the optical parmeters by neglecting the spatial effect only for the thinner film with the thickness much smaller than the wavelength accompanied with the condition to satisfy that $\delta < \pi$, otherwise, the film equation used for the periodic or non-periodic structures will be modified by including the spatial-effect in the data analysis and applications.

12. 光频电磁波在天然金属/介质边界的传输特性研究：金属基微结构在光电子领域具有重要应用前景。在研究中设计和制备了一系列不同入射角的楔形贵金属金薄膜样品。在可见光区，采用垂直入射和光程放大的方法，对三个不同波长激光束的出射折射角进行了精细测量，发现了与波长有关的折射角从负到正的变化规律，定性地与群速度折射率随波长变化的规律相符，其改变符号的区域处于电子带内和带间跃迁的相交区，与相速度折射率随波长变化的梯度有关。在最简单天然金属／空气界面实验观察到的正负折射率变化的现象将有助于人们探索和理解光在物质中传播时速度发生快慢变化的物理起源。

We have studied the wavelength-dependent refraction going from negative to positive in the visible region for pure air/Au by fabricating a series of prism-like Au film samples. Results qualitatively agree with dispersion of the group refractive index, n_g , in which the spectral properties of the phase refractive index, n_p, play a significant role to make both the magnitude and sign of n_g change in the energy region where interband transitions occur. The net refraction observed for the simplest air/metal interface will stimulate further exploration of the physical origin of slow or fast light characterized by the law of refraction in nature.

13. 红外多光栅二维光谱折叠光谱分析研究： 为了满足光通信领域密集波分复用实时光谱分析和监控的需求，在研究中采用 10 块 600g/mm 光栅集成，700 毫米焦距，紧凑型光路双折叠，无任何机械位移部件，将 1450－1650nm 波长区的光谱 10 重折叠后，成像在二维 InGaAs 阵列探测器的焦平面上，从而将光谱的探测长度有效地扩展到 96mm。经系统定标，光谱分析系统具有优于 0.1nm 的分辨率，能够在小于 5ms 时间内完成全光谱数据的获取和分析。新型高分辨光谱系统将能够在许多快速光谱获取和分析的研究和产业领域获得重要应用。

We have completed the study and construction of a new type of InGaAs spectrometer which uses a two-dimensional InGaAs array detector and an integrated grating consisting of 10

sub-gratings with 600g/mm groove density and 700mm focal length. The effective spectral images of about 96mm along the dispersion direction have been densely folded by 10 times to cover the full 1450-1650nm working wavelength range without any mechanical moving element. The results show that the system has a spectral resolution and acquisition time of better than 0.1nm and less than 5ms, respectively, in the entire spectral range after system calibration. The spectrometer will have the advantage and potential to be used for rapid spectral extraction and analysis in many applications.

二、研究项目与成果 Research Projects and Results

2007 年度，本组承担了国家自然科学基金项目 2 项、上海市光科技和自然科学基金重大项目各 1 项、教育部新世纪优秀人才计划 1 项、国家自然基金重大项目子课题 1 项，以及上海市科委重大项目子课题 1 项。完成一项上海市科委的浦江人才计划项目一项。另外，本年度还获得一项国家自然科学基金项目。共发表 SCI 文章 12 篇，发表国际会议论文 8 篇以及国内会议论文 3 篇。申请国家发明专利 1 项。

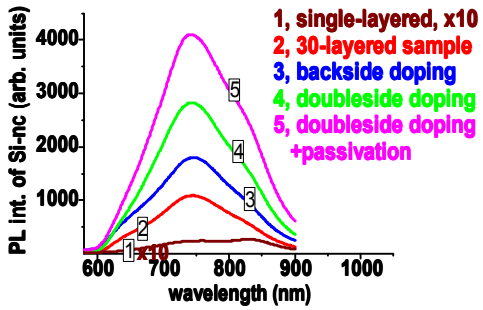
In 2007, our group has been carrying out 7 research projects, including 2 NSFC regular projects, 1 key project from Shanghai committee of science and technology, 1 key project from Shanghai natural science foundation, 1 new century excellent talent program of education ministry， 1 sub-project from a grand project of NSFC and 1 sub-project from a grand project of Shanghai committee of sciences and technology. In addition, a new regular project has been approved by NSFC. We have published 12 research papers in SCI Journals and 8 papers in international conferences and 3 papers in domestic conference. 1 national invention patent has been submitted for application.

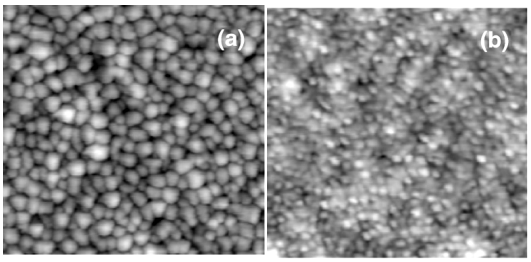
纳米晶的调制及发光 / Preparation, Modification and Luminescence of Nanocrystals

成员：陆明 赵有源　　Group Members: Lu Ming，Zhao Youyuan

◆Si 纳米晶的增强发光　　Enhanced photoluminescence of Si nanocrystals
◆离子束刻蚀形成表面 Si 纳米晶阵列　　Si nanocrystal arrays induced by ion sputtering
◆$SrTiO_3$ 纳米晶的发光调节　　Modification of photoluminescence of $SrTiO_3$ nanocrystals

在 Si 纳米晶发光增强方面，利用我们独创的稀土掺杂方法并结合超晶格技术和钝化手段，使镶嵌在 SiO_2 基体中的 Si 纳米晶光致荧光 PL 强度增强了 2 个数量级，PL 效率达到 53.7%，远大于目前国际先进水平（~10%），已具备作为实用 Si 光源材料的可能性。研究结果在 2007 年 10 月美国举行的 26 届 ICALEO 国际会议上作邀请报告。另外，利用离子束刻蚀方法制备 Si 表面的纳米晶阵列，研究了它们的形成机制，结构以及电学特性，得到了新的结果，有助于这类 Si 纳米晶的调控及其发光研究，目前和德国 Dresden 技术大学合作，开展深入研究。我们通过离子束辐射结合化学腐蚀，还调节了 $SrTiO_3$ 纳米晶的分布和组份，由此调节其发光强度和波长。研究结果为氧化物基电子学器件设计提供了一个新的途径。





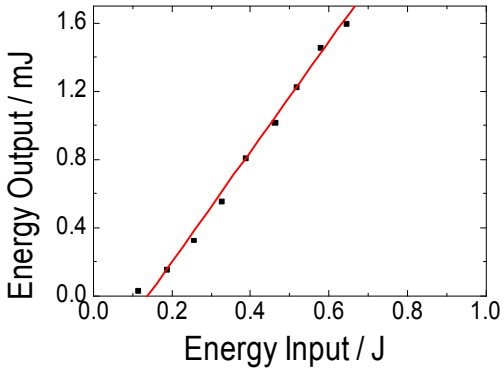
Using our recently developed method of rare earth doping together with superlattice technology and passivation approach, we enhance the photoluminescence intensity of Si nanocrystals embedded in SiO_2 by 2 orders of magnitude with PL efficiency of 53.7%, an efficiency much greater than the best one ever reported (~10%). The result makes this type of Si nanocrystal material promising in practical Si light source designing, and was presented as an invited talk in the 26th ICALEO congress held in USA in October 2007. We also prepared Si nanocrystal arrays on Si surfaces by means of ion sputtering, and studied their formation mechanism, structure and electric properties. The new results are helpful for the modification of these Si nanocrystals and investigation of their luminescent properties. A cooperation program is underway between our group and Technical University Dresden, aiming at these purposes. By using ion sputtering method and chemival etching, we also modified the distribution and composition of $SrTiO_3$ nanocrystals. With this, the photoluminescence of $SrTiO_3$ was readily modified in both intensity and emitting wavelength, which provides a new dimension to the device application of $SrTiO_3$ in oxide-based electronics.

有机光电功能材料及器件 / Organic Optoelectronic Functional Materials and Device

成员：彭波 韦玮 Group Members: Peng Bo，Wei Wei

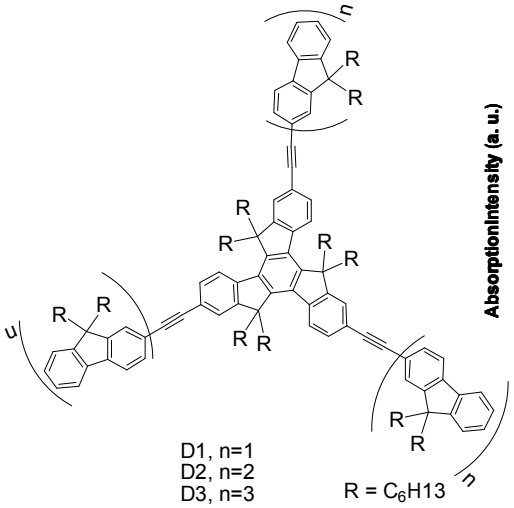
- ◆ 新型流体激光材料与性能
- ◆ 有机/聚合物光电材料与器件
- ◆ Novel liquid laser media and optical feature
- ◆ Materials and devices of organic/polymeric functional Molecules

（1） 新型流体激光介质与性能的研究取得突破性进展。激光的输出特性：激光阈值能量 116 mJ，斜率效率为 0.32%，最大激光输出能量为 1.59 mJ。

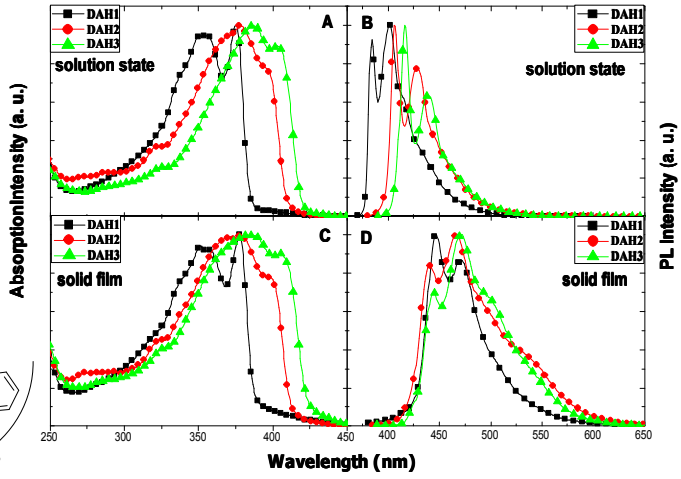


有机流体激光的输入和输出特性曲线

（2） 设计/制备了系列超支化和星状发光聚合物与寡聚物，这些材料具有良好的溶解性、成膜性、光热稳定性和高效的发光性。器件结果显示：最大亮度 2866 cd/m^2，启动电压 3.6 V，流明效率达到 1.55 cd/A。



星状寡聚物



星状寡聚物的紫外－可见吸收光谱和荧光光谱

（1）A great progress has been made in the novel liquid lasers materials. The threshold energy of the laser reaches 116 mJ, the slope efficiency is about 0.32%, and the maximum laser output power reaches about 1.59 mJ.

（2）Design and preparation a series of novel hyperbranched and star-shaped oligomers and polymers. Those materials possess good solubility and film-forming, excellent optical and thermal stability, and high fluorescence efficiency. The maximum luminance of device is 2866 cd/m^2; the turn-on voltage is 3.6 V; and its luminance efficiency reaches 1.55 cd/A.

氮氢共掺杂氧化钛纳米材料的可见光催化研究 / Study on the visible-light photocatalytic abilities of N:H-codoped TiO_2 nanoparticulate films

成员：王培南 糜岚 Group members: Wang Peinan, Mi Lan

锐钛矿相的纳米氧化钛在环保和能源领域有广泛的应用。但氧化钛的光催化必须使用紫外光，紫外类光催化通常必须利用人工紫外光源，这就使应用成本非常高，极大阻碍了它们的应用推广。通过掺氮可以将氧化钛的光学吸收边从紫外区移到可见光区，将可以利用廉价的太阳光做能源进行光催化反应，用于环境净化和杀菌消毒等方面，从而大大降低使用成本。因此研究掺氮氧化钛的合成和催化效率的提高具有重要的应用前景。

我们使用自行研制的氮离子束源，用低能氮离子注入方法对 PLD 制备得到的纯氧化钛薄膜进行了有效的填隙型氮掺杂，有别于已见报道的高能氮离子注入得到的置换型的掺氮形式。通过调节离子束流和能量，可以控制氧化钛薄膜的掺氮量，并且保持锐钛矿相不变。表面含氮量可以达到 3.4 %，其可见光催化能力比纯氧化钛明显增强。结果发表在 ***Applied Surface Science***, **253** (2007) 7024

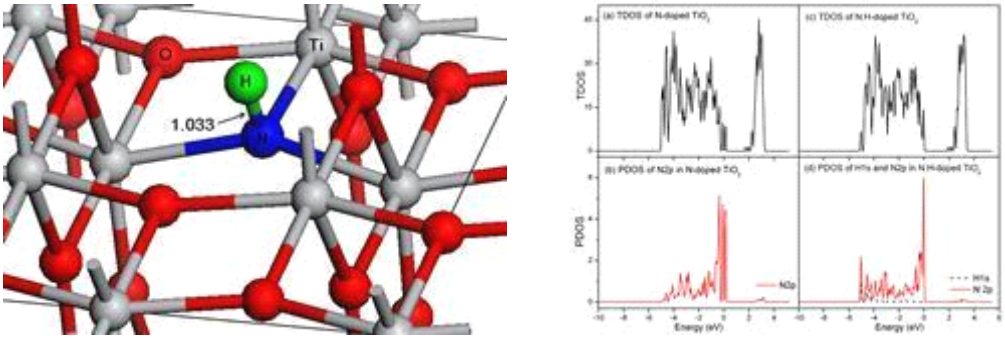
TiO_2 in anatase phase has been widely applied in environmental protection and energy fields. However, TiO_2 has photoactivity only under ultraviolet (UV) light. The photocatalysis has to use artificial UV light source, which increases the cost seriously and obstructs the wide application of the material. Nitrogen doping into anatase can shift its absorption edge from UV to the visible light region, so that the sunlight can be effectively utilized for photocatalytic applications, such as environmental cleaning and antibacterial. Study on the synthesis of nitrogen doped TiO_2 will impose a profound positive effect on enhancing the photocatalytic efficiency, which is of importance for the wide application of TiO_2.

N-doped TiO_2 films were prepared by implantation of low energy nitrogen ions into pure TiO_2 films, which were synthesized by means of pulsed laser deposition (PLD). The doped nitrogen was mainly interstitial, which was different from the substitutional N-doping obtained by high energy nitrogen ion implantation as reported by other groups. The dopant concentration was up to 3.4 % and could be controlled by adjusting the ion flow and implantation energy. It was found that low energy implantation did not change the anatase phase of TiO_2 films. The visible-light photocatalytic abilities were greatly improved as compared with the undoped TiO_2. This work was published in ***Applied Surface Science***, **253** (2007) 7024.

在制备掺氮氧化钛薄膜时发现使用氨做氮源往往会有很好的效果，究竟氢在氧化钛材料的能隙改变和催化的改善中有什么作用是很值得研究的。我们基于第一性原理首次对氧化钛掺氮和氮氢共掺杂以后吸收带红移的机理进行了理论研究。在 4%的掺杂浓度下，从能带结构和态密度的分析，我们发现氮氢共掺杂会导致带隙变窄和吸收边红移，而相同掺氮浓度的掺氮氧化钛的带隙变化则很小。这个计算结果，可以很好地解释我们以前实验中得到的结果，即氮氢共掺杂氧化钛比掺氮氧化钛有更强的可见光吸收和更高的可见光催化效率。上述结果已经发表在 ***Appl. Phys. Lett.*** **90** (2007) 171909。

A remarkable improvement of optical absorption in the visible light region was obtained when we used ammonia as the nitrogen source for the film preparation. It is worthy to study the effect of the incorporated hydrogen on the band gap narrowing and visible-light photoactivity of the material. The band gaps of the N-doped and N:H-codoped anatase TiO_2

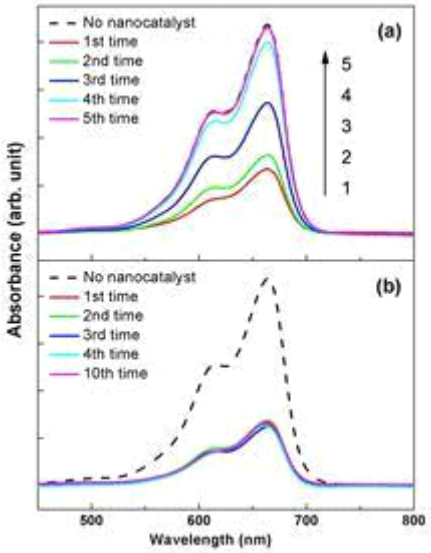
were calculated by first-principles density-functional theory calculation. From the calculated energy structures and density of states, we found for the first time that at the same nitrogen dopant concentration of 4 %, the N:H-codoping yields a significant band gap narrowing, while N-doping only caused a very small band gap narrowing. These results provide a well explanation for our experimental data that the N:H-codoped TiO_2 redshifted the absorption edge effectively and had a significantly improveed photocatalytic ability in the visible-light region. This work was published in ***Appl. Phys. Lett.*** **90** (2007) 171909.



Partial geometry of N:H-doped anatase TiO_2 and calculated band structure of N-doped and N:H-codoped TiO_2.

掺杂氧化钛材料在使用时，催化效率会很快降低，这对实际应用带来很大的困难。因此催化效率的恢复对实际应用时的重复使用尤为重要。我们首次采用了温和加热方法对已经使用过的薄膜进行后处理，结果发现其光催化效率可以完全恢复，这对于材料的实际应用具有重要意义。这些结果已经发表于 ***J Photoch Photobio A***, **193** (2008) 222。

The photocatalytic ability declined rapidly with the operating time. The deactivation of the material will result in a poor reusability, which is unfavorable to the practical applications. Therefore, the recovery of photocatalytic ability is crucial for TiO_2 to have higher commercial potentials. We used the method of mild-heating for the first time to regenerate the N-doped TiO_2 photocatalytic films. It was found that the photocatalytic ability of the used film was fully recovered by this treatment, which is of particular importance for the practical applications. This work was published on ***J Photoch Photobio A***, **193** (2008) 222.



(a) Absorption spectra of the MB solution with catalyst for different times of use. (b) The film was heat treated after each use.

等离子体特性及其在功能材料制备上的应用 / Characteristics and applications of plasma in materials preparation

成员：吴嘉达　许宁　　Group members: Wu Jiada, Xu Ning

对 ECR 微波放电和脉冲激光烧蚀联合过程和在此共同作用下引发的 ECR-PLA 等离子体的时空特性研究表明，ECR 等离子体和 PLA 等离子体之间存在强烈的相互作用，主要表现在：（1）PLA 等离子体对 ECR 等离子体的增强激发 — ECR 微波放电可以引发高活性的 ECR 等离子体，在 ECR 等离子体环境中对固体靶的 PLA 作用和 PLA 等离子体的膨胀不但使得 ECR 等离子体不再保持空间上的均匀性和时间上的稳定性，还可以进一步增强对 ECR 等离子体的激发，使得 ECR 等离子体具有更高的化学活性；（2）ECR 等离子体对 PLA 等离子体的延续激发 — PLA 等离子体可以具有很高的化学活性，但是随着 PLA 等离子体的演变它的活性很快消失，ECR 等离子体对 PLA 等离子体也有增强激发作用，这种增强激发主要发生在 PLA 等离子体演变的后期，也即 ECR 等离子体使得 PLA 等离子体延续较长的时间，这种延续激发有效延长 PLA 等离子体的活性；（3）ECR 等离子体中的活性物质和 PLA 等离子体中的活性物质之间的气相化学反应 — PLA 等离子体在 ECR 等离子体中的膨胀进一步激发 ECR 等离子体、增加 ECR 等离子体的活性，PLA 等离子体也由于 ECR 等离子体对它的延续激发而延长了活性，两种等离子体相互间的增强激发在时间和空间上的重合使得 ECR-PLA 等离子体中活性物质以很高的速率发生气相化学反应。我们在实验上观察到 PLA 等离子体对 ECR 等离子体的增强激发和 ECR 等离子体对 PLA 等离子体的延续激发，也检测到两种等离子体混合而成的 ECR-PLA 等离子体中活性物质之间气相化学反应的产物。

结合各种气体放电和激光烧蚀等离子体特性研究，开展了基于等离子体的材料制备新方法的摸索，包括利用辉光放电等离子体定向喷射的辉光放电等离子体束沉积方法，利用双激光束双靶共烧蚀和ECR等离子体辅助双激光双靶共烧蚀的薄膜沉积和原位掺杂方法，获得1项发明专利，申请2项发明专利。并在此基础上开展了几种功能薄膜材料的合成制备和相关机理研究。对于CH_4/N_2混合气体辉光放电等离子体束沉积CN薄膜过程的等离子体光谱测量分析，观察到等离子体中C和N的气相反应并检测到反应产物CN。用ECR氧等离子体辅助脉冲激光沉积方法在晶格失配的Si(100)衬底上常温生长了具有较高c轴取向的ZnO纳米晶薄膜，图1为ZnO纳米晶薄膜的AFM二维和三维形貌图，图2为ZnO纳米晶薄膜的XRD图样。对ZnO薄膜实施N、As、Bi、Al等元素掺杂和双元素共掺杂研究ZnO导电类型的转变，得到了部分p型ZnO薄膜。用反应脉冲激光沉积和双激光双靶共烧蚀沉积方法制备得到具有较强光致发光的Si纳米晶镶嵌SiO_2薄膜。

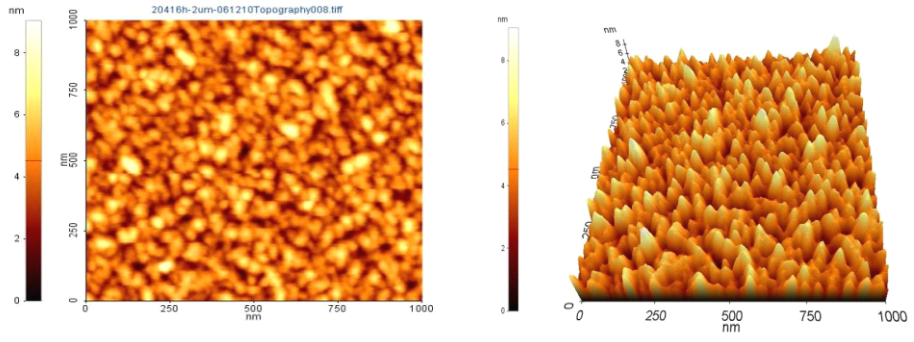


图 1 在 Si(100)衬底上常温生长的具有较高 c 轴取向的 ZnO 纳米晶薄膜的 AFM 图

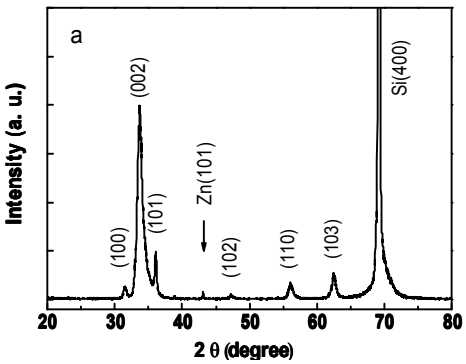


图 2 在 Si(100)衬底上常温生长的具有较高 c 轴取向的 ZnO 纳米晶薄膜的 XRD 图

本年度结题国家自然科学基金项目2项，获得上海市科委国际合作基金项目1项，已获授权发明专利1项，发表学术论文5篇，另有1篇SCI论文在印、1篇已接受。

We have observed strong interactions between ECR plasma and PLA plasma during the hybrid process of electron cyclotron resonance (ECR) microwave discharge and pulsed laser ablation (PLA) and the evolution of the generated ECR-PLA plasma. (1) Enhanced excitation of ECR plasma by PLA plasma — Pulsed laser ablation of a solid target and the expansion of the PLA plasma in the ECR plasma make the ECR plasma vary with time and space. Moreover, the expansion of the PLA plasma results in excitation enhancement of the ECR plasma and makes it more reactive. (2) Prolonged excitation of PLA plasma by ECR plasma — The ECR plasma also enhances the excitation of the PLA plasma expanding in the ECR plasma. The excitation enhancement of the PLA plasma occurs at the late stage of the evolution of the PLA plasma, which results in a longer lifetime for the PLA plasma and prolongs the reactivity of the PLA plasma. (3) Gas phase reactions between the reactive ECR plasma species and the reactive PLA plasma species — The enhanced excitation of the ECR plasma by the PLA plasma and the prolonged excitation of the PLA plasma by the ECR plasma occur in the ECR plasma region where the PLA plasma is expanding. The near coincidence in time and space for the excitation enhancement of these two plasmas allows efficient reactions between the reactive ECR plasma species and the reactive PLA plasma species at high rates. We have observed the enhanced excitation of the ECR plasma and prolonged excitation of the PLA plasma and detected products of the gas phase reactions in the ECR-PLA plasma.

In combination with the research on various gas discharge and laser ablation processes and the characteristics of the generated plasmas, we explored and developed news methods for materials synthesis based on plasmas, including glow discharge plasma beam deposition by means of oriented ejection of glow discharge plasma, film deposition and in-situ doping by means of two-target co-ablation by two laser beams with and without assistance of ECR plasma. One patent was granted and another two applied. We also synthesized several kinds of functional thin films and studied the related mechanisms. During the deposition of CN films by glow discharge plasma beam deposition, we have observed the reactions between C and N and detected the CN molecules

in CH_4/N_2 glow discharge plasma. We have succeeded in low-temperature c-axis oriented growth of nanocrystalline ZnO thin films on mismatched Si(100) substrates by ECR oxygen plasma assisted pulsed laser deposition. Work is also being carried on about the preparation of ZnO films doped with N, As, Bi or Al as well as co-doped with two elements and about the study of their electronic properties. Some p-type ZnO thin films have been prepared. By means of reactive pulsed laser deposition and two-target co-ablation by two laser beams, we have succeeded in the preparation of Si nanocrystals embedded in SiO_2 matrix with strong photoluminescence.

In this year, two NSFC projects were accomplished and one Shanghai International Cooperation (AM) project was approved. One patent was granted. Five papers were published and another one is in press and one was accepted for publication.

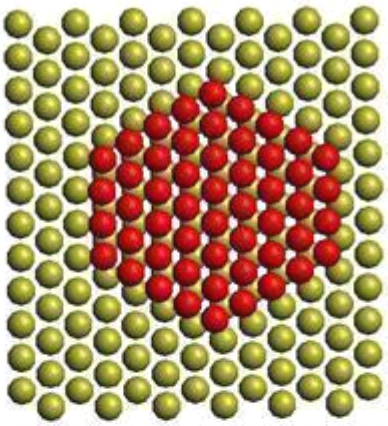
金属表面吸附原子及团簇的扩散动力学研究 / Studies on self-diffusion of adatoms and adatom clusters on metal sufaces

成员：庄军 Group member：Zhuang Jun

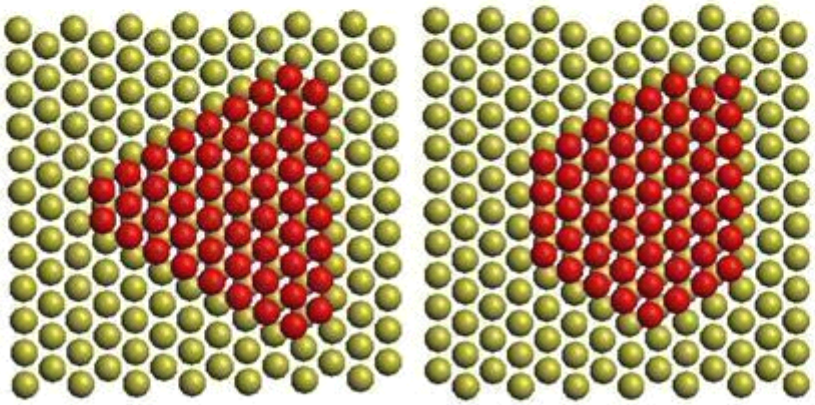
利用遗传算法和原子嵌入势，我们获得并研究了在 Ni, Cu, Au, Ag 和 Pt 的(111)表面的吸附团簇的较低能量结构(LES)。依据最近邻(NN)、次近邻(NNN)吸附原子之间的相互作用和吸附团簇的边的类型这三种因素，我们讨论并解释了较低能量结构的特征，能量分布，异构体的数目，和它们随着表面性质与原子尺寸的变化。在 Ni, Cu, Au 和 Ag 的(111)表面，占主导的是最近邻吸附原子的相互作用。因此，LES 群中只存在一种类型的结构，也就是拥有最多 NN 键数目的 NNmax 结构。而且，NNmax 结构的所有异构体都包括在 LES 群中。但是在 Pt(111)表面，除最近邻吸附原子相互作用外，吸附团簇的边也成为了一个影响团簇能量的重要因素。团簇的边反映了吸附原子和基底原子之间的相互作用。于是，由于不同类型的边之间的差的增加，不同于在 Ag(111)表面，除了 NNmax 结构，NNmax-1,NNmax-2 等结构也进入了 LES 群中。更有趣的是，这些在 LES 群中的结构的类型会随着团簇尺寸的增大而不断的得到更新。也就是，在 Pt(111)表面的 LES 群中不是只有一种类型的结构，而是会最终稳定在三种结构。而在各个类型的结构中，只有那些不同类型的边之间的差最大的异构体才能进入到 LES 群中。基于上面两种不同表面的结果，我们还可以预测其它类型表面的较低能量结构。最后，较低能量结构所对应的是实验上处在一定温度下的平衡态的结构，因此它们在不同表面之间的区别可以在团簇的平衡态形状上反映出来。根据我们的结果，在 Ni, Cu, Au, 和 Ag 的(111)表面，团簇是六角形的，而在 Pt(111)表面，由于存在结构类型的替换现象，团簇是三角形。这些结果和实验的观测符合得很好。

On Ni, Cu, Au, Ag and Pt(111) surfaces, the lower energy structures(LESes) of adatom clusters are studied with the embedded atom method. The structures in the LES group are obtained by the genetic algorithm. The structural feature, energy distribution, number of the isomers, and their variations with the surface characteristics and the cluster size are discussed and explained in terms of the NN, NNN adatom-adatom interactions, and the edge-type difference. On Ni, Cu, Au, and Ag(111) surfaces, the NN adatom-adatom interaction is dominant. So, in LES group, there is only one type of structure, i.e., NN_{max} structure, and the whole of its isomers are included. On Pt(111) surface, however, besides the NN adatom-adatom interaction the edge-type difference which reflects the strength of the adatom-substrate interaction is also a main factor for the cluster energy. As results, different from that on Ag(111) surface, besides the NN_{max} structure the NN_{max-1}, NN_{max-2}, etc., could also enter into the LES group due to the increment of the edge-type difference, and the types of the structures are refreshed by an interesting structure replacement phenomenon with increasing cluster size. That is, on Pt(111) surface, the number of the structure types in the LES group are generally not one, it is finally stable at around three by the structure replacement phenomenon. Moreover, in the respective structure groups, e.g., NN_{max} and NN_{max-1} structure groups, etc., only the part isomers with the maximum edge-type differences could be included in the LES group on Pt(111) surface. Base on the results on these two different surfaces, one can predict the lower energy structures on the other surfaces. Finally, the LESes obtained here are corresponding to the equilibrium structures at certain temperature in experiment, and their differences on the various surfaces can be seen from the shape of the island.

From our LESes on Ni, Cu, Au, and Ag(111) surfaces, we see that the shape of the cluster is hexagonal. While, on Pt(111) surface, due to the existence of the structure replacement phenomenon, the shape of the cluster is triangular. The results are well in accordance with the experimental observations.



Ag(111)表面的吸附团簇，原子数 n=52



Pt(111)表面的吸附团簇，原子数 n=52

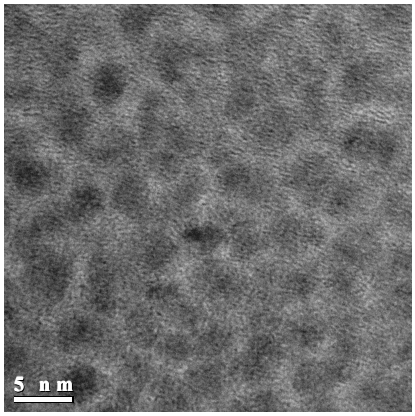
有机半导体的自旋电子学研究 / Spintronics in organic semiconductors

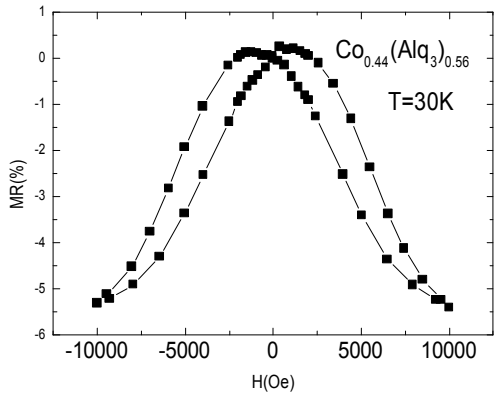
成员：倪刚 Group Member: Ni Gang

- 磁性有机半导体复合薄膜的输运性质/Transport properties of magnetic organic semiconductor hybrid films
- 磁性有机半导体复合薄膜的磁光效应/ Magneto-optical Kerr effects in magnetic organic semiconductor hybrid films

我们采用真空共蒸镀膜的方法，制备了不同组分的 $Co_x(Alq_3)_{1-x}$ 的磁性金属与有机半导体复合的颗粒膜样品，在其中发现隧穿磁电阻效应。我们发现在逾渗值附近的样品中呈现较大的磁电阻效应，这可能与其微结构特征有着密切关联。此外，我们还对 $Co_x(Alq_3)_{1-x}$ 颗粒膜的磁光效应进行了研究，在其中观察到极化克尔效应，有着较大的克尔旋转角。并且随着 Co 含量的增加，增强峰逐渐红移。这一现象与颗粒膜的微结构特征以及磁性可能有着密切的关系。

我们还研究了磁场对磁性电极的有机小分子电致发光器件的电致发光效应的影响。





A series of $Co_x(Alq_3)_{1-x}$ granular film samples were prepared using co-evaporating technique. The microstructures, magnetic, magneto-transport properties and Magneto-optical Kerr effects in these samples were investigated systemically. The HRTEM images show typical characteristics of granular films, with average size of 1-5 nm.The negative tunneling magnetoresistance has been found in these samples, reaches -5.6% at 30K in x=0.44 samples. The possible mechanism of transport behavior was investigated. The large Kerr effect has been found in high Co fraction samples, and the relationship between metal fraction and the red shift of the peak was discussed.

The OLED devices with magnetic metal cathode were fabricated successfully, showing good EL performance. The dependence of electroluminescence (EL) intensity on the magnetic field has been investigated. It is shown that the EL intensity of the devices increases 9% under the magnetic field of 1.5kOe and the driving voltage of 10V.

液晶光电子器件 / Liquid crystal electro-optical devices

成员：刘建华 戴海涛 徐克璹 Group Members: Liu Jianhua, Dai Haitao, Xu Keshu

1. 可编程空间光调制器及其在聚合物分散液晶(PDLC)光学元件制备中的应用 /Programmable Spatial Light Modulator and Its Application in Fabricating Optical components of Polymer Dispersed Liquid Crystal

用一块具有1024×768显示分辨率的商品化的LCOS 构建了一套空间光调制器, 能够很容易地用计算机产生的控制信号形成可编程光掩模, 并将其应用于多种基于聚合物分散液晶的光学元件的制备研究中. 作为实例之一, 制备了一种可调PDLC 的三级Fresnel 波带透镜, 衍射效率可从61%到4%连续调节. 最大衍射效率与理论预期相符.

A commercialized LcoS panel with the display capacity of 1024 × 768 was adopted to construct a spatial light modulator, which can be easily controlled by computer video signals to generate programmable photomasks. This photomask can be used to make various kinds of optical components based on polymer dispersed liquid crystal (PDLC) materials. A three-level Fresnel zone lens (FZL) of PDLC as an example was fabricated using this programmable photomask, whose diffraction efficiency (DE) ranged between 61% and 4% as the applied electric field was varied. The maximum value of DE was in a good agreement with the theoretical predication for three-level Fresnel zone.

2. 高质量宽频检测的实用改进型电化学衰减全反射表面增强红外光谱/ Practically modified attenuated total reflection surface-enhanced IR absorption spectroscopy for high-quality frequency-extended detection of surface species at electrodes

衰减全反射表面增强红外光谱(ATR-SEIRAS)是研究电极界面结构和反应机理的重要方法。为确保工作电极的电化学稳定性和代表性，传统 SEIRAS 技术多使用硅柱作为红外窗口并在其反射面上沉积金属薄膜电极。不幸的是，由于硅柱在 1000 cm^{-1} 以下有较强的吸收，无法给出相应的红外信号，使该方法的应用能力受到制约。为克服此弱点，本文根据“衰势波穿透深度原理”和“平面波棱柱-膜耦合理论”，在硒化锌柱和硅片之间引入超薄水层，大大提高了多种入射角度下红外光在两不同折射率固相的穿透量，实现高质量宽频采谱目标。利用此实用新型 ATR-SEIRAS 系统，可同时获得电极表面吸附物种在 700-850 cm^{-1} 的面外振动和 1000-1700 cm^{-1} 面内振动模式谱峰，从而可靠地鉴定出甲醇在铂电极上的电氧化活性中间体甲酸根；同时也据此，详细解析了芳香分子 PNBA 在电极表面上的吸附构型。

A practically modified ATR configuration has been proposed for in situ electrochemical surface-enhanced IR absorption spectroscopy (SEIRAS) by sandwiching an ultrathin water interlayer between a hemicylindrical ZnSe prism and a Si wafer as an integrated window. This new ATR optics significantly enhances the throughput of an effective IR beam across the ZnSe/gap/Si/metal film, enabling high-quality spectral fingerprints down to 700cm-1 to be readily detected at larger incidence angles without compromising the electrochemical feasibility and stability of metallic films deposited on Si. The advantages of this modified ATR-SEIRAS have been initially applied to explore two selected systems: wide-ranged in situ ATRSEIRA spectra provided strong evidence in support of the formate intermediate pathway for methanol electrooxidation at the Pt electrode in an acid solution; in addition, new spectral fingerprints revealed comprehensive orientational information about of the p-nitrobenzoate species at Pt electrode as a result of the dissociative adsorption of p-nitrobenzoic acid molecules from an acid

solution.

3. 分形波带片焦距的精细调节特性和分辨率特性研究/ The research on the properties of resolution and finely-tuning foci of FraZPs

继续深入的研究了分形波带片的聚焦特性,对比了分形波带片和普通的波带片的焦距调节特性, 实验和理论研究均证明通过调节分形波带片缺项的数值可以得到比普通波带片更为精确的焦距控制. 但是精确的焦距控制是以衍射效率的降低为代价的. 为克服分形波带片焦点大小(分辨率)随着阶次的降低而降低的缺点,提出了级联分形波带片的概念,这种新型的波带片保持了精确调节焦距的特点的同时,提高了分形波带片的分辨率.

Focusing properties of FraZPs were studied in details. By compared with common Zone Plates, it was proved that the focal length of FraZPs could be tuned more finely by varied lacunarity according the experimental results and theoretic analysis. But the diffraction efficiency would be decreased for phase mismatch. To overcome the drawback that the foci dimension (resolution) of FraZPs would reduce with its order dropped, one novel FraZPs, Cascade FraZPs, was introduced, this novel FraZPs improving the resolution capability with the fine foci tuning property kept.

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[27 李毅刚，黄剑平，李颖峰，李皓，何耀基，顾劭忆，陈光辉，刘丽英，徐雷；溶胶凝胶法制备高掺镱光纤预制棒新工艺的研究；第七届全国光学前沿问题讨论会，广西桂林，2007.10.28-11.1

[28] 吴翔，李皓，刘丽英，徐雷；高 Q 值有机无机复合光学微腔激光器的制备以及光学性质的测量； 第七届全国光学前沿问题讨论会，广西桂林，2007.10.28-11.1

[29] 单炯，杨佩，刘丽英，徐雷；偶氮染料光致异构的瞬态动力学行为和偶氮染料掺杂薄膜的三倍频研究；上海激光学会年会，2007.11

[30] 张启明，刘伟，刘丽英，徐雷；飞秒光与连续光辐照诱导硫系玻璃的三阶光学非线性的变化； 上海激光学会年会，2007.11

[31] 邱静燕，胡婧婷，刘丽英，徐雷；分散红掺杂聚合物和凝胶玻璃的二阶光学非线性研究； 上海激光学会年会，2007.11

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学位论文/Dissertations

1. 博士学位论文

[1] 盛明裕，**光频电磁波在薄膜结构中传播的空间干涉现象研究及应用**；导师：陈良尧

[2] 谢国强，**激光二极管泵浦的固体激光器研究**；导师：钱列加

[3] 宋清海，**新型光学微腔激光器的构造及其方向性激光出射的研究**；导师：徐雷

[4] 杨　华，**中红外飞秒光参量放大技术研究**；导师：范滇元

[5] 陆大全，**真空激光远场电子加速机制中相关光学问题的研究**；导师：范滇元

[6] 李永忠，**光纤中的超短脉冲光参量效应研究**；导师：范滇元

[7] 糜　岚，**掺杂二氧化钛纳米颗粒膜的制备及其可见光催化特性和机理研究**；
导师：王培南

[8] 刘　秀，**光激励下有机分子重取向诱导的液晶三阶光学非线性的动力学过程研究**；
导师：干福熹，徐 雷

2. 硕士学位论文

[1] 魏慎金，**掺杂对 $Ge_2Sb_2Te_5$ 相变薄膜物性的影响和热辅助磁记录(HAMR)静动态测试系统的初步研制**；导师：李晶

[2] 陆舟军，**荧光显微技术在细胞生物学中的应用**；导师：王培南

[3] 贾李琛，**矢量衍射理论在信息存储多层膜中的应用研究**；导师：郑玉祥

[4] 冯守志，**尺寸可控的硅纳米晶及硅纳米晶与二氧化硅复合薄膜的椭圆偏振光谱研究**；
导师：陈良尧

[5] 吴　遐，**BiOx 和 ZrO_2 氧化物信息功能薄膜制备及性质研究**；导师：李晶

[6] 张贻松，**磁性隧道结中电流诱导的磁化翻转模拟研究**；导师：张宗芝

[7] 张　璋，**电化学模板辅助新型磁性纳米材料的研究**；导师：金庆原

[8] 张廷卫，**脉冲激光沉淀技术制备 ZnSe 薄膜材料**；导师：许宁

[9] 张成先，**超短激光脉冲信噪比的测量及提高方法研究**；导师：朱鹤元

[10] 顾　闻，**可见光波段电磁波在金属/空气界面传输规律实验研究路**；导师：陈良尧

[11] 孙海彤，**离子束溅射致硅纳米点的电学性质研究**；导师：陆明

[12] 解志强，**硅纳米晶的光致发光及发光增强研究**；导师：陆明

[13] 陈　丹，**硅纳米晶的电致发光研究**；导师：陆明

[14] 蒋建兴，**金属表面吸附团簇自扩散动力学研究**；导师：庄军

[15] 谢世祥，**聚酰亚安波导材料和期间的研究**；导师：韦玮

[16] 赵晓萌，**磁性有机半导体颗粒膜的微结构、磁性和输运性质的研究**；导师：倪刚

[17[殷　刚，**金属纳米颗粒的光学性质及 Ni_2MnGe 材料结构和电子性质的理论研究**；
导师：王松有

主办国际会议/International Conferences Sponsored by the Laboratory

第 5 届中韩双边光子学科技研讨会：2007-10-21；浙江

第 5 届中韩双边光子学科技研讨会在 2007 年 10 月 21 日-26 日在浙江千岛湖召开，会议主席是复旦大学信息学院院长陈良尧教授，副主席是韩国汉阳大学量子光科学研究中心主任 Young-Pak Lee 教授和中科院上海微系统与信息技术研究所曹俊诚研究员。

研讨会旨在交流光子学领域最新科技成果，研讨领域新的发展趋势，加强中韩学者之间的交流合作。研讨会主要内容包括：1）材料的光学性质及应用光学，2）超快光子学，3）纳光子学，4）光子器件。

学术组织与期刊任职/Academic Service

国际学术组织任职/Service to the International Professional Societies

干福熹	国际光学工程学会资深会员 1998-
Gan Fuxi	Fellow，International Society for Optical Engineering (SPIE)
	美国光学学会资深会员 1990-
	Fellow，Optical Society of America (OSA)
金庆原	IEEE 国际磁学学会技术委员会委员；2005-2006
JinQingyuan	Member , IEEE Magnetics Society Technical Committee

国际期刊任职/Service to the International Journals

干福熹 Gan Fuxi

国际《非晶态固体》杂志编辑委员会委员 1982-

Member of Editorial committee international journals USA《Noncrystalline Solids》

国际《光学材料》杂志编辑委员会委员 1992-

Member of Editorial committee international journals USA《Optical Materials》

国际《玻璃物理与化学》杂志编辑委员会委员 1996-

Member of Editorial committee international journals U.K《Glass physics and chemistry》

《马来西亚科学》杂志编辑委员会委员 1994-

Member of Editorial advisory committee international journals《Malaysia Science》

《马来西亚固体科学和技术》杂志编辑委员会委员 1994-

Member of Editorial committee international journals 《Malaysia Solids Science and Technology》

国内学术组织任职/ Service to the Domestic Professional Societies

干福熹	中国硅酸盐学会名誉理事长	2004-
金庆原	中国光学学会基础光学专业委员会副主任	2005-
徐　雷	上海激光学会副理事长	2005-
钱列加	中国宇航学会光电专委会常务理事	2005-
王培南	上海激光学会理事	2005-
陈良尧	中国光学学会理事	2006-
	中国宇航学会光电专委会常务委员	2007-

国内期刊任职/Service to the Domestic Journals

干福熹	《辞海》编委会, 副主任	2004-
	《无机材料学报》顾问	1985-
	《自然科学进展》顾问	1992-
	《材料研究学报》顾问	1998-
	《光学学报》顾问	1998-
	《功能材料》杂志编辑顾问委员会委员	1990-
	《硅酸盐通报》杂志编辑顾问委员会委员	1995-
	《河南大学学报》杂志编辑顾问委员会委员	2000-
	《中国光电医学》杂志编辑顾问委员会委员	1992-
	《世界科技研究与发展》；杂志编辑顾问委员会委员	1995-

客座研究课题及来访人员/ Open Subjects & Guest scientists

重点实验室高访学者研究课题/Open Subjects

序号	课题名称	负责人	职称	工作单位	起止时间
1	主动光学用新型硫系玻璃及性能表征	陈国荣	教授	华东理工大学	2006.7 -2008.7
2	纳米材料激光处理和表征	陆永峰	教授	Univ. of Nebraska -Lincoln,USA	2006.7 -2008.7
3	介质研究的学术培训和技术指导	陆斌	技术主管经理	Seagate Technology，USA	2006.12 -2008.12
4	collaborate with Prof. Liejia Qian in the area of ultrafast and nonlinear optics.	许春晖（Chris Xu）	副教授	Cornell Univ.,USA	2006.12-2008.12
5	新型液晶显示模式设计研究	吴诗聪(Shin-Tson Wu)	教授	美国中佛罗里达大学（UCF）	2007.7 -2009.7
6	给学生开设相关培训课程，详细介绍磁记录领域发展，以及介质研究的关键技术和实验方法	刘小晰	副教授	日本国信州大学工学部信息工学科	2007.7 -2009.7
7	研究半导体量子点/嵌段聚合物复合膜的光谱性质	陈鑫	副研究员	中科院上海技术物理所	2007.7 -2009.7
8	给学生和教师开设培训课程，详细介绍电流诱导磁化翻转效应的物理原理及微纳米器件制备的关键技术工艺	Paulo Freitas	教授	Physics Dept. of instituto superior tecnico and INESC MN, Lisboa, Portugal	2007.7 -2009.7
9	建立基于紧束缚近似的理论研究方法	王才壮	研究员	Ames Laboratory-USDOE	2007.7 -2009.7
10	辅助国家基金委重大项目“超高密度光磁混合数字信息存储”的实施	王建平	副教授	Electrical and Computer Engineering Dept.Univ.of Minnesota, USA	2007.7 -2009.7
11	开展异型微腔传感、单频激光等方面的合作	范旭东	副教授	University of Missouri - Colombia	2007.12 -2009.12
12	纳米液晶的非线性光学效应及光角动量和自旋交换方面的合作研究	Lorenzo Marrucci	副教授	意大利那波里大学	2007.12 -2009.12
13	利用单分子技术对核糖体蛋白质穿膜、核糖体组装和核糖体穿膜进行系统研究	杨炜东	副教授	Bowling Green State University，USA	2007.12 -2009.12

来室访问及作报告的学者/ Guest scientists & some visitors

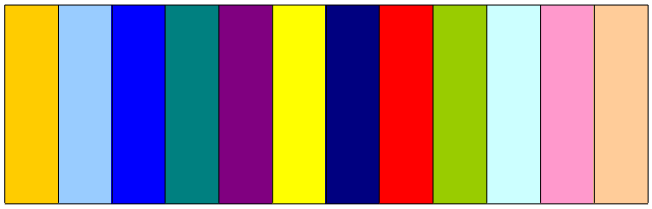
序号	学者姓名及身份	国别	讲学（访问）内容	时　间
1	Prof. Shin-Tson Wu,美国中佛罗里达大学	美国	来室访问	2007.3.15
2	Prof. Chen Jingsheng, Prof. Chow, Prof. Ding, Data storage institute , Singaport	新加坡	来室访谈	2007.3.15
3	刘言军博士，新加坡理工大学	新加坡	HPDLC及随机激光研究的新进展	2007.3.16
4	Prof. Kevin O'Grady 英国York 大学，原IEEE国际磁学学会主席	英国	The mechanism of exchange bias	2007.3.19
5	Prof. Gung Chern,国立中正大学，台湾自旋科技研究中心主任	台湾	The study of MRAM at Taiwan SPIN research center	2007.3.19
6	Prof. Jerry L.Hudgins, Dept. Chair of Electrical Engineering, Univ. of Nebraska-Lincoln	美国	The University of Nebraka and the Department of Electrical Engineering	2007.3.27
7	Sina Balkir, Associate Prof. of Electrical Engineering and Graduate Committee Chair, Univ. of Nebraska-Lincoln	美国	Graduate Education and Research in engineering at University of Nebraska-Lincoln	2007.3.27
8	Prof. Richard K Chang,Yale University USA	美国	来室访谈	2007.4.4
9	Dr. Rachel Pei Chin Won, Nature Photonics副编辑	美国	介绍Nature Photonics这本新杂志的专题报告并参观实验室	2007.6.12
10	Dr.车晓东, Hitachi Global Storage Technologies USA	美国	来室指导	2007.6.12 -20
11	Prof. Jian-Ping Wang , Univ. of Minnesota, Dept. of electrical and computer engineering	美国	Exchange coupled composite (ECC) magnetic recording media	2007.6.28
12	Prof. Jian-Ping Wang , Univ. of Minnesota, Dept. of electrical and computer engineering	美国	Spin torque transfer and novel spintronic devices	2007.6.29
13	Prof. Jian-Ping Wang , Univ. of Minnesota, Dept. of electrical and computer engineering	美国	New magnetic nanoparticles	2007.7.5
14	曾浩教授，university of Buffalo-suny	美国	Multifunctional nanostructure via chemical routes	2007.7.10
15	Chris Xu, Associate Prof. Department of Appl. Eng. Phys., Cornell Univ.	美国	Applied nonlinear and ultrafast optics	2007.7.12

16	干效松博士，Swinburne University of Technology, Australia	澳大利亚	中澳青年团来室访问	2007.7.30-8.2
17	Prof. Barry R. Masters, Biological Engineering Division Massachusetts institute of technology	美国	来室访问	2007.9.25
18	Prof. Barry R. Masters, Biological Engineering Division Massachusetts institute of technology	美国	Confocal microscopy and multiphoton excitation microscopy and their applications to bio-medicine in the areas of ophthalmology and dermatology	2007.9.26
19	Prof.Min Gu(顾 敏)， Centre for Micro-Photonics, Faculty of Engineering and Industrial Sciences, Swinburne Univ. of Technology, Australia	澳大利亚	三微生物光子学	2007.11.5
20	Prof.Min Gu(顾敏)，同上	澳大利亚	Nanophotonics with femtosecond laser	2007.11.9
21	Prof.dr.H.P.Urbac， Delft Univ. of Technology, Netherlands	荷兰	From THzto EUV Research in the optics group of Delft Univ. of Technology, Netherlands	2007.11.15
22	Prof. Kostya (Ken) Ostrikov Plasma Nanoscience, School of Physics, The University of Sydney, Australia	澳大利亚	Self-assembled nanodevices on plasma-exposed surfaces: a myth or reality?	2007.11.22
23	Prof. Kobayashi 日本东北大学	日本	Physical properties of phthalocyanine and the potential conjugation to quantum Dots	2007.12.11
24	Scott Yan,PhD, Assistant professor,electrical and computer Engineering Queen's Univ.	加拿大	High-speed data transmission over multimode fiber	2007.12.12
25	Dr. Wen Xian Zhang, Department of physics and Astronomy Dartmouth College, USA	美国	Spin-1 Bec and coherent control of electron spin decoherence in a quantum dot	2007.12.13
26	Dr. Xudong(Sherman) Fan, Assistant professor, Biological Engneering Department Univ.	美国	Optofluidic ring resonators: the interface between photonics and fluidics	2007.12.14
27	方伟博士，Atomic physics devision, NIST	美国	From regularity to chaos: studies on semiconductor microdisks and deformed microdisk lasers	2007.12.18
28	Dr. Xiang Peng, Senior research scientist,Raydiance Inc,USA	美国	Some general concepts of high power ultrashort pulse(USP) fiber lasers and their applications	2007.12.24

复旦大学光科学与工程系

Department of Optical Science & Engineering

ANNUAL REPORT



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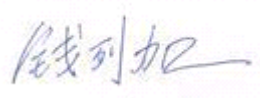
前　言

光学是研究光的本性、光的产生与控制、光的传输与检测、光与物质相互作用以及光在科学研究和技术中的各种应用的学科，其中光学材料、光谱并行探测和光存储均起着关键性的作用。光学是已有知识的综合体，既包含科学也包含工程技术，涵盖了基础研究、技术发展、工程应用三个环节，最终通过光通讯、光存储、光显示、高功率激光等主体技术促进经济发展、人类健康和国家安全。

复旦大学光科学与工程系是个光荣的集体，是国内少数几个同时涉及国家重点一级学科、二级学科与国家重点实验室的单位和部门之一。2000 年复旦大学新成立了光科学与工程系，独立地承担本科生教育、研究生培养、光学重点学科建设和国家重点实验室的发展工作。主要从事超快非线性光学技术、微光子学材料与器件、超高密度纳米混合存储、凝聚态光谱学和新型光电材料等 5 个方向的研究工作。

2007 年，光科学与工程系承担 36 项科研任务（其中包括 973 课题 1 项，863 课题 3 项，国家自然科学基金重大、重点和面上项目 22 项，其它项目 10 项），凭借人才、技术经验和装备条件取得了骄人业绩。在中外学术期刊上发表文章 71 篇（其中 Advanced Materials 1 篇，Physical Review Letters 1 篇，Applied Physics Letters 7 篇，Opt. Express 6 篇，Optics Letters 2 篇，Physical Review A 2 篇），国际会议邀请报告 7 篇，授权发明专利 7 项。

过去的一年，本系在教育、科研和学科建设方面又取得了长足的进步，特别是顺利通过了光学国家重点学科的评估，并积极准备了国家重点实验室的评估工作，我们非常感谢全体成员和客座教授对光科系作出的贡献。同时，我们也清醒地认识到，我们还需要经过长时间的努力，将教师的能力、科研成果、教育质量以及毕业生的社会影响力集成在一起，成为一个和谐发展的整体，展示现有成绩，促进光科学与工程系的今后发展。为此，我们需要对自己有要求、对集体负责任、提高学术境界和眼光，持续不断地通过点点滴滴的小进展，最终积累成为更大的成功。



复旦大学信息学院光科学与工程系主任

2008 年　上海