上海交通大学研究生专业课程信息收集表

Information Form for SJTU Graduate Profession Courses

<table>
<tr><th colspan="6">课程基本信息 Basic Information</th></tr>
<tr><td>*课程名称
Course Name</td><td colspan="5">（中文 Chinese）薄膜材料与技术
（英文 English）Thin Film Materials and Technique</td></tr>
<tr><td>*学分
Credits</td><td>3</td><td>*学时
Teaching Hours</td><td colspan="3">48（1 学分=16 课时）</td></tr>
<tr><td>*开课学期
Semester</td><td>秋季学期 Fall</td><td>*是否跨学期
Cross-semester?</td><td>否 No</td><td colspan="2">跨 Spanning over 个学期 Semesters（含夏季学期）。</td></tr>
<tr><td>*课程类型
Course Type</td><td>专业选修课 Program Elective Course</td><td>*课程分类
Course Type</td><td colspan="3">全日制课程 For full-time students</td></tr>
<tr><td>*课程性质
Course Category</td><td>专业课 Specialized Course</td><td>课程层次
Targeting Students</td><td colspan="3">博士课程 Doctoral Level</td></tr>
<tr><td>*授课语言
Instruction Language</td><td>中文 Chinese</td><td>主要授课方式
Teaching Method</td><td colspan="3">课堂教学 In class teaching</td></tr>
<tr><td>*成绩类型
Grade</td><td>等第制 Letter grading</td><td>主要考核方式
Exam Method</td><td colspan="3">论文 Essay</td></tr>
<tr><td>*开课院系
School</td><td colspan="5">材料科学与工程学院</td></tr>
<tr><td>所属学科
Subject</td><td colspan="5">材料学，</td></tr>
<tr><td rowspan="2">负责教师
Person in charge</td><td>姓名 Name</td><td>工号 ID</td><td colspan="2">单位 School</td><td>联系方式 E-mail</td></tr>
<tr><td>戴永兵</td><td></td><td colspan="2">材料科学与工程学院</td><td>ybdai@sjtu.edu.cn</td></tr>
<tr><th colspan="6">课程扩展信息 Extended Information</th></tr>
<tr><td>*课程简介
(中文)
Course Description</td><td colspan="5">（分段概述课程定位、教学目标、主要教学内容、先修课程等；不少于 200 字。）

课程定位：本课程是面向材料科学与工程及其他相关学科博士生的一门专业选修课。
教学目标：本课程旨在使学生比较系统地掌握薄膜材料与技术的基础知识，了解该领域科学研究及产业发展的现状与趋势，为将来从事薄膜相关的专业工作打下坚实基础。
主要教学内容：本课程将较为系统地介绍薄膜材料与技术的基础知识，主要内容包括薄膜材料基本特性、薄膜制备技术、薄膜表征技术、薄膜模拟技术、薄膜图形化技术、印刷电子学（将薄膜制备与图形化合二为一的技术）、薄膜应用等几大部分。
先修课程：材料科学基础</td></tr>
<tr><td>*课程简介
（English）
Course Description</td><td colspan="5">（须与中文一致，翻译请力求信达雅。）

"Thin Film Materials and Technique" is a specialized elective course for doctoral students majoring in materials science and engineering, and those in other related disciplines.
This course aims to enable students to systematically grasp the basic knowledge of thin film materials and technique, have a general understanding of the developing trends and some frontier directions in this field, and lay a solid foundation for future career related to thin film materials.
This course will systematically introduces the fundamentals of thin film materials and technique, including the basic characteristics of thin film materials, and their preparation, characterization, simulation, patterning techniques and applications. Besides, a newly emerging discipline, i.e., printed electronics, which features the combination of the preparation and patterning of thin film materials in one simple, flexible and low-cost technique will also be covered.
Prerequisite course: Fundamentals of Materials Science</td></tr>
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*教学大纲 (中文) Syllabus	（建议列表形式，各列内容：章节、主要内容、课时数、教学方式等）

章节	主要内容	课时数	教学方式
第一章. 薄膜材料基本特性 1．薄膜的定义 2．薄膜中的尺寸效应 3．薄膜与基片 4．内应力	薄膜的定义及其与厚膜的关系，薄膜中的主要尺寸效应，薄膜/基片系统的特性及附着力测量方法，内应力及薄膜剥离现象。	3	课堂讲授、课堂讨论
第二章. 薄膜制备技术 1．气相沉积技术 2．非气相沉积技术	两种气相沉积技术：物理气相沉积与化学气相沉积，物理气相沉积技术中的真空蒸发、分子束外延、激光闪蒸、溅射与反应溅射技术，化学气相沉积技术中的等离子体增强化学气相沉积与金属有机化学气相沉积。非气相沉积技术中的液相外延、固相外延、朗缪尔-布洛杰特法和化学溶液涂层法。	15	课堂讲授、课堂讨论
第三章. 薄膜表征技术 1．薄膜结构表征 2．薄膜显微组织与形貌表征 3．薄膜组分表征	掠入射 X 射线衍射、反射高能电子衍射、椭圆偏振光谱技术的工作原理及在薄膜结构表征中的应用，透射电镜、扫描电镜及扫描探针显微镜在组织与形貌表征中的应用，二次离子质谱、俄歇电子能谱、光电子能谱在薄膜组分测定中的应用。	3	课堂讲授、课堂讨论
第四章. 薄膜模拟技术 1．常用分子模拟技术 2．薄膜生长的分子动力学模拟 3．非晶薄膜的结构与物性	常用的两种分子模拟技术——分子动力学与蒙特卡罗方法的基本原理，分子动力学方法在薄膜生长模拟中应用的技术细节，非晶薄膜的双体相关函数、键角分布函数、静态结构因子计算及环元统计。	15	课堂讲授、课堂讨论、课堂测验、大作业
第五章. 薄膜图形化技术 1．常用薄膜图形化技术 2．掩模版的制作	三种常用的薄膜图形化技术及其优缺点，湿法刻蚀与干法刻蚀，掩模版的制作方法	3	课堂讲授、课堂讨论、
第六章. 印刷电子学 1．印刷电子学基本概念 2．印刷技术 3．可印刷材料 4．基片与阻挡层	印刷电子学的基本概念及其应用领域，几种常用的印刷技术：网版印刷、喷墨打印、凹版印刷、柔版印刷、平版胶印、纳米压印、微接触打印，印前印后处理工艺，咖啡环效应，可印刷导体材料：金属、有机物、陶瓷、碳纳米材料，可印刷半导体材料：有机半导体、氧化物半导体、硅，基片材料：PET、PEN、	6	课堂讲授、课堂讨论

		PI、玻璃、纳米纤维素、不锈钢，两类水、氧阻挡层：被动式阻挡层与主动式阻挡层。		
	第七章．薄膜应用 1．半导体电子器件 2．磁性器件 3．压电、热释电器件 4．耐磨耐蚀涂层	半导体薄膜在制作薄膜晶体管、薄膜太阳能电池等电子器件中的应用，磁性薄膜在制作磁阻与磁光器件中的应用，压电、热释电薄膜在制作换能器、红外检测与成像器件方面的应用，超硬薄膜涂层（金刚石、类金刚石薄膜）在耐磨耐蚀领域的应用。	3	课堂讲授、课堂讨论

*教学大纲（English）Syllabus

（须与中文一致，翻译请力求信达雅。）

Chapter	Main content	Credit hour	Teaching method
Chapter 1. The basic characteristics of thin film materials 1. The definition of thin film 2. The size effects in thin film 3. Thin film and substrate 4. Internal stress	The definition of thin film and its relation to thick film. The main size effects in thin film. The characteristics of thin film/substrate system and the adhesion measurement methods. Internal stress and film exfoliation.	3	class lecture, class discussion
Chapter 2. The preparation techniques of thin films 1. Vapor deposition techniques 2. Non-vapor deposition techniques	Two kinds of vapor deposition techniques: physical vapor deposition (PVD) and chemical vapor deposition (CVD), PVD techniques: vacuum evaporation, molecular beam epitaxy (MBE), pulsed-laser ablation, sputtering and reactive sputtering, and CVD techniques: plasma-enhanced chemical vapor deposition (PECVD), metal-organic chemical vapor deposition (MOCVD). Non-vapor deposition techniques: liquid-phase epitaxy, solid-phase epitaxy, Langmuir-Blodgett method, and chemical solution coating.	15	class lecture, class discussion
Chapter 3. The characterization techniques of thin films 1. Structure characterization of thin films 2. Microstructure and morphology characterization of thin films 3. Composition characterization of thin films	The working-principles of grazing-incidence X-ray diffraction (GIXRD), reflection high-energy electron diffraction (RHEED), spectroscopic ellipsometry (SE) and their applications in the structure characterization of thin films. The applications of transmission electron microscope (TEM), scanning electron microscope (SEM), and scanning probe microscope (SPM) in the microstructure and morphology characterization of thin films. The applications of secondary ion mass spectrometry (SIMS), Auger electron spectroscopy (AES), and photoelectron	3	class lecture, class discussion

	spectroscopy (PES) in the composition characterization of thin films.		
Chapter 4. The simulation techniques of thin films 1. Commonly-used molecular simulation techniques 2. The growth simulation of thin films via molecular dynamics method 3. Structures and physical properties of amorphous thin films	The principles of two commonly-used molecular simulation techniques: molecular dynamics (MD) and Monte Carlo (MC) methods. The technical details of the application of MD method in the growth simulation of thin films. The calculation of pair correlation function (PCF), bond-angle distribution function, static structure factor (SSF), and ring statistics of amorphous films simulated by MD method.	15	class lecture, class discussion, quiz, big project
Chapter 5. The patterning techniques of thin films 1. Commonly-used patterning techniques of thin films 2. Mask fabrication	The merits and shortcomings of three kinds of commonly-used patterning techniques of thin films, wet etching and dry etching. The fabrication methods of mask.	3	class lecture, class discussion
Chapter 6. Printed electronics 1. Basic concept of printed electronics 2. Printing technology 3. Printable materials 4. Substrate and barrier layer	The basic concept of printed electronics and its applications. Several commonly-used printing technologies: screen printing, inkjet printing, gravure printing, flexographic printing, offset printing, nanoimprint, and microcontact printing (μCP), pre- and post-printing processes, coffee-ring effect. Printable conducting materials: metallic materials, organic materials, ceramics, and carbon nanomaterials. Printable semiconductor materials: organic semiconductor, oxide semiconductor, silicon. Substrate materials: PET, PEN, PI, glass, nanocellulose paper, stainless steel. Two kinds of barrier layers for preventing water vapor and oxygen transmission: passive and active barrier layers.	6	class lecture, class discussion
Chapter 7. The applications of thin films 1. Semiconductor electronic devices 2. Magnetic devices 3. Piezoelectric and pyroelectric devices 4. wear and corrosion resistant coatings	The applications of semiconductor thin films in the fabrication of electronic devices, such as thin film transistors (TFTs), thin film solar cells. The applications of magnetic thin films in the fabrication of magnetoresistive and magneto-optical devices. The applications of piezoelectric and pyroelectric thin films in the fabrication of transducer, infrared detection and imaging devices. The applications of superhard thin films (e.g., diamond and diamond-like carbon) in the field of wear	3	class lecture, class discussion

		and corrosion resistance.		

*课程要求 （中文） Requirements	（课程考核方式、考核标准等；不少于 50 字） 在课堂学习及自学的基础上，选择薄膜材料与技术方面的一个专题进行文献调研与总结，写一篇不少于 3000 字的专题论文并据此作一次 15 分钟左右的口头报告。论文与口头报告各占最终成绩的 50%。
*课程要求 （English） Requirements	（须与中文一致，翻译请力求信达雅。） Based upon learning in classroom and by themselves, students are required to choose a specific topic in the field of thin film materials and technique, and after literature survey and summary, write a paper with no less than 3000 Chinese characters and then make an oral presentation about 15 minutes accordingly. The paper and the oral presentation will each account for 50% of the final grade.
*课程资源 （中文） Resources	（教材、教参、网站资料等。） 教学参考书： 1．薄膜生长，吴自勤等著，科学出版社（2013） 2．电子薄膜科学，[美] 杜经宁等著，黄信凡等译，科学出版社（1997） 3．印刷电子学：材料、技术及其应用，崔铮等编著，高等教育出版社（2012） 4．薄膜材料科学（第二版），[英]奥林著，刘卫国等译，国防工业出版社（2013）
*课程资源 （English） Resources	（须与中文一致，请力求信达雅。） Reference: 1. Thin Film Growth, Ziqin Wu et al., Science Press (2013) 2. Electronic Thin Film Science, King-Ning Tu et al., Macmillan (1992) 3. Printed Electronics: Materials, Technologies, and Applications, Zheng Cui et al., Higher Education Press (2012) 4. Materials Science of Thin Films: Deposition & Structure (2nd edition), M. Ohring, Academic Press (2002)
备注 Note	