南方科技大学
SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

课程详述

COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	**课程名称 Course Title**	半导体材料基础 Fundamentals of Semiconductor Materials
2.	**授课院系 Originating Department**	深港微电子学院 School of Microelectronics
3.	**课程编号 Course Code**	SMES205
4.	**课程学分 Credit Value**	2
5.	**课程类别 Course Type**	专业选修课 Major Elective Courses
6.	**授课学期 Semester**	夏季 Summer
7.	**授课语言 Teaching Language**	英语 English
8.	**授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师）Instructor(s), Affiliation& Contact（For team teaching, please list all instructors）**	夏光睿(Guangrui Xia) 副教授, 材料系，英属哥伦比亚大学 Department of Materials Engineering, the University of British Columbia, gxia@mail.ubc.ca
9.	**实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact**	待公布 To be announced
10.	**选课人数限额(可不填) Maximum Enrolment（Optional）**	

		讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other（Please specify）	总学时 Total
11.	授课方式 Delivery Method					
	学时数 Credit Hours	20	6	6		32

12.	先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	无
13.	后续课程、其它学习规划 Courses for which this course is a pre-requisite	无
14.	其它要求修读本课程的学系 Cross-listing Dept.	无

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

本课程主要讲解和半导体材料相关的材料科学工程基础，主要材料分析方法/理论和半导体工业实践中的主要材料问题。This course is designed to teach the fundamentals of material science and engineering and major material analysis methods, theories and practice related to microelectronic and photonic industry.

16. 预达学习成果 Learning Outcomes

通过本课程的学习，学生们将学会：

1. 主要半导体材料，半导体器件的分类，应用。

2. 区分晶体的晶胞和原胞，理解 14 种布拉维点阵。

3. 理解晶体的晶面，晶向，晶面族，晶向族的概念，使用米勒指数标出晶体的晶面和晶向。计算原子面间距。

4. 理解晶体的各类缺陷，计算点缺陷的浓度。理解材料适配的概念和不适配的问题。计算简单的应力和热应变。

5. 理解硅和氮化镓的不同应用，画出硅和氮化镓的晶胞主要晶向和晶面。列出硅，氮化镓中的主要掺杂元素。了解主要化合物半导体的能带，对应的吸收光谱和晶格常数。

6. 理解主要材料分析技术的使用工作原理和限制，包括原子力显微镜, X 光衍射，电镜，化学蚀刻，二次电子质谱仪和隧道电子显微镜。

7. 应用布拉格定理标定 X 光衍射峰和米勒指数。使用张量形式胡克定律计算的应力应变。理解粉末衍射和单晶衍射的区别，用 X 光衍射的方法来测量晶面的倾角和鉴别晶向。

8. 理解实验室的安全要求和规章制度。

After completing this course, the students will be able to:

1. List major semiconductors, semiconductor devices, products based on semiconductor materials and applications

2. Understand the concept of primitive cells, unit cells and the 14 Bravais lattices.

3. Use Miller indices in labelling crystal directions, planes, and families. Calculate interplanar distances of lattices.

4. Identify various defect types in common semiconductors and calculate interstitial and vacancy concentrations in equilibrium. Understand the significance of crystallinity, lattice matching and thermal expansion matching

5. Compare Si and GaAs in the applications, sketch Si and GaAs unit cell, identify (with Miller indices) and sketch major crystal orientations and planes. List common dopants in Si and identify intrinsic and extrinsic semiconductors. Learn the relation between the energy bandgap and the absorption wavelength.

6. Understand the use, working principle and the limitations of major material analysis techniques such as XRD, AFM,

SEM, EPD, SIMS and TEM in industry and research practice. 7. Apply Bragg's law to identify XRD peaks and their Miller indices, and calculate strains. Apply the tensor format of the Hook's law for simple stress and strain cases. Understand the difference between powder diffraction and single crystal diffraction. Use the XRD technique to measure wafer title angles and orientations. 7. Understand common epitaxy techniques. Calculate lattice mismatch strains and thermal strains. 8. Understand basic lab safety operation rules and regulations.

17. 课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）
Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

1. (2 hours) 主要半导体材料，半导体器件的分类，应用。Major semiconductors, semiconductor devices, products based on semiconductor materials and applications 2. (1.5 hours) 晶体的晶胞和原胞，14 种布拉维点阵。 Concept of primitive cells and unit cells and the 14 Bravais lattices. 3. (1.5 hours) 晶体的晶面，晶向，晶面族，晶向族的概念，米勒指数标出晶体的晶面和晶向。原子面间距。 Miller indices in labelling crystal directions, planes, and families. 4. (3 hours) 晶体缺陷，点缺陷的浓度。材料适配的概念和不适配的问题。计算简单的应力和热应变 Material defects, crystallinity, epitaxy, lattice mismatch and thermal expansion mismatch 5. (6 hours) 硅和氮化镓的不同应用，硅和氮化镓的晶胞主要晶向和晶面，主要掺杂元素。主要化合物半导体的能带，对应的吸收光谱和晶格常数。主要材料分析技术的使用工作原理和限制，包括原子力显微镜, X 光衍射，电镜，化学蚀刻，二次电子质谱仪和隧道电子显微镜。Si and GaAs as two major semiconductors. Major material analysis techniques such as XRD, AFM, SEM, EPD, SIMS and TEM. 6. (1 hours) 实验室安全操作和规程。basic lab safety rules and practice. 7. 课堂练习 Tutorials (6 hours) on a. 晶胞和米勒指数 unit cells and Miller indices, b. 材料分析 material analysis tools and examples. 8. 期中考试 one in-class midterm and feedback (2 hours) 9. 期末报告 Final presentations, discussions and feedback: (3 hours) 10. (2 hours) 扫描电镜 SEM measurement on-site observations 11. (2 hours) X 光衍射 XRD measurement on-site observations 12. (2 hours) 实验室安全认知 Lab safety on-site demonstrations

18. 教材及其它参考资料 **Textbook and Supplementary Readings**

1. Materials Science and Engineering: An Introduction by William D. Callister, David G. Rethwisch

课程评估 ASSESSMENT

19.

评估形式 **Type of Assessment**	评估时间 **Time**	占考试总成绩百分比 **% of final score**	违纪处罚 **Penalty**	备注 **Notes**
出勤 **Attendance**				
课堂表现 **Class Performance**				
小测验 **Quiz**				
课程项目 **Projects**				
平时作业 **Assignments**		18		
期中考试 **Mid-Term Test**		40		
期末考试 **Final Exam**				
期末报告 **Final Presentation**		20% 口头报告和幻灯片 for the final presentation and slides, 20%书面报告 for the final report		
其它（可根据需要改写以上评估方式） **Others (The above may be modified as necessary)**	教学调查问卷 Teaching survey participation	2		

20. 记分方式 **GRADING SYSTEM**

■ A. <u>十三级等级制 **Letter Grading**</u>
☐ B. 二级记分制（通过/不通过） **Pass/Fail Grading**

课程审批 REVIEW AND APPROVAL

21. 本课程设置已经过以下责任人/委员会审议通过
This Course has been approved by the following person or committee of authority
