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）材料动力学
（英文 English）Kinetics of Materials</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>春季学期 Spring</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>专业基础课 Program Core 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">硕博共用 All graduates</td></tr>
<tr><td>*授课语言
Instruction Language</td><td>英文 English</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">笔试 Written Exam</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"></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>单位 School</td><td colspan="2">联系方式 E-mail</td></tr>
<tr><td>汪洪</td><td></td><td>上海交通大学</td><td colspan="2">hongwang2@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。）
本课程为深入理解材料的唯象和原子动力学过程提供了基础。它强调对基本概念的理解，强调培养学生的定量分析能力。本课程从简单回顾理解相图所必需的经典热力学开始，接着是一些关键概念，如通量和驱动力。介绍了化学反应动力学的基本原理，以及在薄膜生长、化学气相沉积等方面的重要应用。课程的中心部分是固体材料中的扩散过程，以及解决扩散问题的分析和数值方法。然后讨论了毛细力驱动的动力学过程，随后是晶体的成核、生长和相变。讨论了几种重要的冶金过程，如凝固、调幅分解等。在课程结束前，学生将接触到热力学和动力学的计算机模拟方法和软件的基础知识。

本课程的总体目标是：
1) 通过强调和扩展材料热力学课程中的概念，理解材料和微观组织发生变化的原因；
2) 通过讨论扩散的机理和速率以及驱动力对扩散过程的作用，了解扩散如何促进材料化学分布和微观结构的变化；
3) 讨论各种相变现象以及温度和驱动力对转变性质的影响及其对所得微观结构的影响；
4) 介绍在当今的材料设计和开发中变得越来越重要的热力学和动力学模拟方法和软件。
总之，本课程将教授学生提供所需的工具，以理解相变的发生方式和原因，以及控制微观组织的方法和原因。</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。）
This course provides a foundation for the advanced understanding of the phenomenological and atomistic kinetic process in materials. It emphasizes comprehension of fundamental concepts and stresses on development of students' ability of quantitative analysis. The course starts from a brief review of classical thermodynamics necessary for understanding of phase diagrams, followed by some key concepts such as flux and driving force. The principles of chemical reaction kinetics will be introduced, as well as several important applications such as in thin film growth process and chemical vapor deposition. The center stage of the course is given to the diffusion process in solid materials as well as the analytical and numerical methods to solve diffusion problems. Then</td></tr>
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	the kinetic process driven by capillarity force will be discussed, followed by nucleation and growth of crystals and the phase transformation. Several important metallurgical processes such as solidification, spinodal decomposition, etc. will be discussed. Before the end of the course, the students will be exposed to basics of computer simulation methods and software for thermodynamics and kinetics. The overall goals of this course are to: 1) develop an understanding of why materials and microstructures undergo changes by reinforcing and significantly extending concepts introduced in thermodynamics courses; 2) provide an understanding of how diffusion enables changes in the chemical distribution and microstructure of materials by discussing mechanisms and rates of diffusion and the role of driving force on diffusional processes; 3) discuss a variety of phase transformations phenomena and the effects of temperature and driving force on the nature of the transformation and its impact on the resulting microstructure; 4) introduce the methods and software for thermodynamic and kinetic simulation, which became more and more important in today's materials design and development; In short, the course will give the students the tools required to understand how and why phase transformations occur, and how and why microstructures can be controlled and developed.
*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） 该课程将分 24 节课，每节课包含两个 45 分钟课时。 I 引言和背景 简介，热力学 1 节 相图，驱动力，通量 1 节 II 化学反应动力学 化学反应动力学，吸附等温线 1 节 薄膜生长，速率控制步骤； 化学气相沉积 1 节 III 固体扩散 菲克定律和菲克定律的解 2 节 互扩散 1 节 自、示踪、本征和互扩散系数 1 节 离子晶体中扩散，扩散的原子模型 1 节 多路径的缺陷 1 节 期中考试 IV 毛细力驱动的动力学 毛细力作用于表面，晶粒生长 2 节 表面能各向异性 1 节 颗粒粗化，烧结 1 节 V 相变动力学 形核与生长 2 节 凝固 1 节 无序反应 1 节 调幅分解 1 节 马氏体转变 1 节 VI 动力学过程模拟 计算热力学（CALPHAD） 1 节 扩散模拟，相场模拟 2 节 计算实践 1 节 期末考试

*教学大纲 （English） Syllabus	（须与中文一致，翻译请力求信达雅。） The class will be delivered in 24 lectures, where each lecture contains two 45min classes. I INTRODUCTION AND BACKGROUND Introduction，thermodynamics 1 lecture Phase diagrams, Driving force, flux 1 lecture II KINETICS OF CHEMICAL REACTIONS Chemical reaction kinetics, adsorption isotherms 1 lecture Thin film growth， Rate controlling steps; CVD 1 lecture III DIFFUSION IN SOLIDS Fick's Laws and solutions to Fick's laws 2 lecture Interdiffusion 1 lecture Self, tracer, intrinsic and interdiffusion coefficients 1 lecture Atomistic models of diffusion, Diffusion in ionic crystals 1 lecture Multipath imperfections 1 lecture Midterm Exam IV KINETICS DRIVEN BY CAPILLARITY FORCES Capillarity forces on surfaces, grain growth 2 lectures Surface energy anisotropy 1 lecture Particle coarsening, sintering 1 lecture V KINETICS OF PHASE TRANSFORMATIONS Nucleation and growth 2 lectures Solidification 1 lecture Order-disorder Reactions 1 lecture Spinodal decomposition 1 lecture Martensitic transformation 1 lecture VI MODELLING OF KINETIC PROCESS Computational thermodynamics (CALPHAD) 1 lecture Diffusion simulation, Phase field simulation 2 lecture Computational lab 1 lecture Final Exam
*课程要求 （中文） Requirements	（课程考核方式、考核标准等；不少于 50 字） 1.10 次家庭作业，每次作业占总分 2%，共 20% 2.期中考试 1 次，覆盖大约 10 次课内容，每次占总分 30% 3.期末考试，覆盖整个学期，占总分 30% 4.出席和课堂讨论，10% 5.测验:简单问题课后交，5% 6.项目:计算模拟操作，5% 最终评定将根据上述总和计算。
*课程要求 （English） Requirements	（须与中文一致，翻译请力求信达雅。） 1. 10 Homework assignments, 2% each, 20% 2. Midterm Exam, covers first 10 lectures，30% each 3. Final Exam, covers later 9 lecture, 30% 4. Participation: attendance and class discussion, 10% 5. Quiz: simple questions due next morning 6:00am after each class, 5% 6. Project: computation lab work, 5% The final grade will be calculated based on the sum of the above.
*课程资源 （中文） Resources	（教材、教参、网站资料等。） 主要课本: KINETICS IN MATERIALS SCIENCE AND ENGINEERING，Dennis W. Readey, CRC Press, 2017

	必要时将在课堂上提供辅助课件 参考书： 1. Phase transformations in metals and alloys, D. A. Porter and K. E. Easterling, Third Eds., Chapman&Hall, London, 2008 2. Diffusion in solids, P. G. Shewmon, Wiley-TMS, 1991 3. Kinetics of materials, R. W. Balluffi, S. A. Allen, W. C. Carter, John Wiley and Sons Inc., New York, NY, 2005 4. Kinetic Processes: Crystal Growth, Diffusion, and Phase Transitions in Materials, K. A. Jackson, Wiley-vch Verlag gmbh, 2004
*课程资源 （English） Resources	（须与中文一致，请力求信达雅。） Textbook: KINETICS IN MATERIALS SCIENCE AND ENGINEERING，Dennis W. Readey, CRC Press, 2017 Additional class material may be provided in the class if necessary Reference books 1. Phase transformations in metals and alloys, D. A. Porter and K. E. Easterling, Third Eds., Chapman&Hall, London, 2008 2. Diffusion in solids, P. G. Shewmon, Wiley-TMS, 1991 3. Kinetics of materials, R. W. Balluffi, S. A. Allen, W. C. Carter, John Wiley and Sons Inc., New York, NY, 2005 4. Kinetic Processes: Crystal Growth, Diffusion, and Phase Transitions in Materials, K. A. Jackson, Wiley-vch Verlag gmbh, 2004
备注 Note	