

# 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

课程基本信息 Basic Information				
<b>*课程名称</b> Course Name	(中文 Chinese) 凝固原理			
	(英文 English) Principles of Solidification			
<b>*学分</b> Credits	3	<b>*学时</b> Teaching Hours	48 (1 学分=16 课时)	
<b>*开课学期</b> Semester	秋季学期 Fall	<b>*是否跨学期</b> Cross-semester?	否 No	跨 Spanning over 一个学期 Semesters (含夏季学期)。
<b>*课程类型</b> Course Type	专业基础课 Program Core Course	<b>*课程分类</b> Course Type	全日制课程 For full-time students	
<b>*课程性质</b> Course Category	专业课 Specialized Course	课程层次 Targeting Students	硕士课程 Master Level	
<b>*授课语言</b> Instruction Language	中文 Chinese	主要授课方式 Teaching Method	课堂教学 In class teaching	
<b>*成绩类型</b> Grade	等第制 Letter grading	主要考核方式 Exam Method	笔试 Written Exam	
<b>*开课院系</b> School	材料学院 SMSE			
所属学科 Subject				
负责教师 Person in charge	姓名 Name	工号 ID	单位 School	联系方式 E-mail
	李建国 Jianguo Li		材料学院 SMSE	lijg@sjtu.edu.cn
课程扩展信息 Extended Information				
<b>*课程简介</b> (中文) Course Description	<p>(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。)</p> <p>凝固作为制造工业中的基础理论学科，为学生掌握快速、近终型智能制造提供工艺设计理论基础。</p> <p>课程主要以金属的凝固过程为例，介绍凝固的基本原理和凝固研究的最新进展。重点讲述凝固组织形成的一般规律、凝固界面形态转变的理论与实践、成分不均匀性及其形成规律、凝固过程常用的控制方法。简要介绍熔体、非晶固体的结构、非晶金属的形成和制备方法、过冷熔体的凝固行为、外场在凝固过程控制中的作用和应用。</p> <p>本课程以材料科学基础、材料加工原理、材料加工过程中的传输现象等课程为先修课程。</p>			
<b>*课程简介</b> (English) Course Description	<p>(须与中文一致，翻译请力求信达雅。)</p> <p><u>As the fundamental theory of industrial manufacturing, solidification provides students with the basic principles of smart casting with high-efficient near net shape forming.</u></p> <p><u>In the course, solidification of liquid metal is taken as an example, both the fundamental theory and the advances in the solidification research are introduced. The general principles for the formation of solidification structure, for the transition of the solidifying interfacial morphology, for the solute redistribution and their controlling approaches will be emphasized. The atomic structure of liquid and amorphous solid, the formation and preparation of amorphous alloy, the solidification behavior of undercooled liquid, the external field effect on the solidification and its control would also be introduced.</u></p> <p><u>To attend this course, fundamentals of materials science, principles of materials processing, transport phenomena in materials processing should be learned in advance.</u></p>			

		(建议列表形式, 各列内容: 章节、主要内容、课时数、教学方式等)				
		序号	章节	主要内容	课时数	教学方式
*教学大纲 (中文) Syllabus		1	凝固-从工艺到科学	凝固现象: 金属、有机、无机材料凝固; 凝固的历史; 凝固和自然科学其他方面的关系; 凝固对材料的重要性	3	课堂讲授
		2	金属熔体结构和凝固热力学	金属熔体结构及其与有机、无机材料的区别; 熔体结构的表征; 金属熔体凝固的热力学原理	3	课堂讲授
		3	单相合金的凝固	凝固过程中的热流; 凝固过程成分的分凝和分布规律; 非平衡凝固: 界面稳定性, 成分过冷原理, 扰动理论和扰动分析; 凝固界面失稳与凝固组织	6	课堂讲授
		4	多相合金的平面前沿凝固	共晶合金凝固: 共晶的形态, 共生共长, 共晶生长的理论模型	3	课堂讲授
		5	铸件和铸锭的凝固	多元多相合金的凝固, 铸锭的凝固, 铸件的凝固, 焊接过程中的凝固问题	3	课堂讲授
		6	熔体的凝固行为与偏析	观察熔体、凝固过程的吸放热、多相合金的偏析行为, 掌握基本的金相分析知识	3	实验参观
		7	熔体过冷和过冷熔体的凝固	熔体的过冷、方法 过冷熔体的热力学性质 过冷熔体的凝固	3	课堂讲授
		8	定向凝固、单晶生长以及金属 3D 打印	定向凝固方法 单晶生长方法 3D 打印过程中的凝固问题	6	课堂讲授
		9	凝固过程的流动与数值计算	凝固过程中流体的流动: 流动与扩散的耦合, 流动与溶质再分配, 流动问题的数值建模, 流动的数值计算	6	课堂讲授
		10	金属非晶的形成及其特性	非晶金属的结构和性质, 非晶金属的获得, 玻璃形成温度	3	课堂讲授
		11	晶粒细化	凝固过程中的晶粒细化理论和方法, 在生产实际中的应用	3	课堂讲授
		12	特种凝固技术	参观并了解定向凝固、单晶生长、3D 打印等特种凝固技术	3	实验参观
				课程考试		3
		(须与中文一致, 翻译请力求信达雅。)				
*教学大纲 (English) Syllabus		No.	Sections	Contents	Hours	Teaching method
		1	Solidification-From craft to science	Solidification phenomena: metal, organic, inorganic; The history of solidification; The relationship between solidification and the other disciplines The importance of solidification to materials	3	Lecture
		2	Liquid structure of metals and thermodynamics of solidification	The structure difference among liquid metal, organic and inorganic; Characterization on liquid metal; Thermodynamics of solidification	3	Lecture
		3	Solidification of	Heat flow in solidification	6	Lecture

	single phase alloys	Solute redistribution during solidification Non-equilibrium solidification: interfacial stability, constitutional undercooling, Perturbation during solidification, Instability of the interface and solidification structure			
4	Planar solidification of multiphase alloys	Solidification of eutectic alloys: the morphology of eutectic alloy, couple growth, J-K model	3	Lecture	
5	Castings and solidification in casting	Solidification of multi-phase alloys, solidification of casting ingots and castings, solidification during welding	3	Lecture	
6	The solidification of liquid metal and its segregation	To observe the liquid metal; the exo and endo thermic behavior; the segregation of multiphase alloys; to know the metallographic knowledge	3	Lab tour	
7	Undercooling of liquid metal and the solidification of undercooled liquid metal	Undercooling of liquid metal and the approaches for undercooling; Thermodynamic properties of liquid metal; Solidification of undercooled liquid metal	3	Lecture	
8	Unidirectional solidification, single crystal growth, 3D printing of metal	Solidification behavior during unidirectional solidification, single crystal growth, 3D printing of metal	6	Lecture	
9	Liquid flow during solidification and its numerical calculation	Liquid flow during solidification; The coupling between liquid flow and diffusion; Liquid flow and solute redistribution Modeling for liquid flow; Numerical calculation of liquid flow	6	Lecture	
10	The formation and features of the metal glass	The structure and properties of metallic glass; The fabrication of metallic glass; The formation temperature	3	Lecture	
11	Grain refinement	The theory of grain refining during the solidification and its application approaches; The industrial application of grain refining	3	Lecture	
12	Special solidification technology	To observe and know the special technology as unidirectional solidification, the single crystal growth, and 3D printing	3	Lab tour	
	Exam		3	Exam	
*课程要求 (中文) Requirements	(课程考核方式、考核标准等; 不少于 50 字) 平时作业=20% 课堂讨论=30% 期末考试=50%				

<p>*课程要求 (English) Requirements</p>	<p>(须与中文一致, 翻译请力求信达雅。) Homework=20% Class discussion=30% Final exam=50%</p>
<p>*课程资源 (中文) Resources</p>	<p>(教材、教参、网站资料等。) <u>M.C. Flemings: Solidification Processing;</u> 中译本: 凝固过程 胡汉起: <u>金属凝固原理</u> 周尧和等: <u>凝固技术</u> <u>W. Kurz: Fundamentals of solidification</u> 中译本: 凝固原理 <u>M.E. Glicksman, Principles of solidification</u></p>
<p>*课程资源 (English) Resources</p>	<p>(须与中文一致, 请力求信达雅。) <u>M.C. Flemings: Solidification Processing;</u> <u>Chinese version: Solidification processing</u> <u>Hanqi Hu, Principles of liquid metal solidification (in Chinese)</u> <u>Yaohe Zhou, et. al, solidification technology (in Chinese)</u> <u>W. Kurz: Fundamentals of solidification</u> <u>Chinese version: Fundamentals of solidification</u> <u>M.E. Glicksman, Principles of solidification</u></p>
<p>备注 Note</p>	