* Course Name	Chinese		
	English FUNDAMENTALS OF SOLIDIFICATION		
* Credits	3	* Teaching Hours	48 1 =16
* Semester	Spring	* ` ls Cross-semester?	No
			For full-time students
* Course Category	Specialized Course	Targeting Students	All graduates
* Instruction Language	English	Teaching Method	In class teaching
* Grade	Letter grading	Exam Method	Essay
* School			
Subject			

Person in charge	Name	ID	School	E-mail
				Zj119@sjtu.edu.cn

* ( ) Course Description	200 - - /
* English Course Description	Fundamental aspects of the melt structure, solute diffusion during solidification, solidification microstructure as well as the utilization of the fundamentals. This course provides an introduction to modern materials science and engineering, and the core theme is how the properties of materials, microstructure, processing history and the performance are inherently interrelated. We shall focus on developing an understanding of relationships between melt- microstructure –properties, which are very important. Properties are greatly affected by solidification, and microstructure is affected by processing and composition. It is hoped that course participates can understand various fundamental concepts of crystal structures, melt structure, defects forming mechanism, diffusion at the liquid/Solid interface, phase diagrams, and learn how to apply these to the investigations of materials during solidification.

* ( ) Syllabus	1. Preface and overview 1.1 What solidification is Conception Importance of solidification (in nature and industry) Conditions for solidification For instance: Water - Ice - Snow 1.2 Essential factors of solidification process Temperature, composition, physical characteristic 1.3 Essential factors of Microstructure Grain size Morphology precipitated phase 2. Melt structure and characteristics 2.1 Experimental Consideration Change in volume on melting Latent heat of melting Entropy of melting Diffraction studies of liquid structure Transport properties 2.2 Theories of Liquid Structure Condensation theories Lattice theories Geometrical theories New development 2.3 Synchrotron radiation SAXS and XRD 3. Nucleation 3.1 Thermodynamic Aspects Conditions for Nucleation Homogeneous nucleation Rate of nucleation 3.2 Nucleation agent Heterogeneous nucleation 3.3 Interface structure TiB2-Al interface Nucleation ability 4. Growth 4.1 Nucleus growth Influencing factors Growth by surface nucleation Growth on imperfections 4.2 External factors Ultrasound effect 5. Morphological instability of a Solid/Liquid interface 5.1 Interface instability of pure substance 5.2 Solute pile-up at a Planar solid/liquid interface 5.3 Interface instability of alloy 5.4 Perturbation analysis 6. Solidification Microstructure: Cells and Dendrites 6.1 Constrained and unconstrained growth 6.2 Morphology and crystallography of dendrites 6.3 Diffusion field at the tip of needle-like crystal 6.4 Operating point of the needle crystal – tip radius 6.5 New style of dendrite – anaxial dendrite 6.6 Primary spacing of dendrites after directional growth 6.7 Columnar- Equiaxed transition 7. Solidification Microstructure: Hypoeutectic, hypereutectic, Eutectic, Peritectic 7.1 Regular and irregular eutectics

	7.2 Diffusion – coupled growth 7.3 Competitive growth of dendrite and eutectic 7.4 Other solidification reactions 8. Solute Redistribution 8.1 Mass-balance in directional solidification 8.2 The solute distribution in directional solidification: solid solute and multi-phases alloy 8.3 Microsegregation – Influence on Laves phase in K4169 alloy 8.4 Characterization of segregation Utilization of segregation 9. Flow in liquid – Macrosegregation 9.1 Flow in liquid metal Heat transfer (radiation, conduction , convection) Solute transfer (diffusion, convection) 9.2 Flow effects on macrosegregation 10. Solidification Methods 10.1 Directional solidification - HRS method (High Rate Solidification) - Czochralski Method 10.2 Rapid solidification - Metal spinning - Spray forming 10.3 Other techniques

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English
Syllabus

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	3.3 TiB2-Al 4. 4.1 4.2 5. / 5.1 5.2 / 5.3 5.4 6. 6.1 6.2 6.3 6.4 - 6.5 —— 6.6 6.7 7. 7.1 7.2 - 7.3 7.4 8. 8.1 8.2 8.3 —— K4169 Laves 8.4 9. - 9.1 9.2 10. 10.1 -HRS - 10.2 - - 10.3

* Requirements	50 : = 20% = 30% = 50%
* English Requirements	Homework = 20% Two calculational homework Discussion = 30% Usual performance Final essay = 50% Final paper, to solve or analyze a problem relevant to your project with taught principles.
* Resources	: [1] W. Kurz, D. J. Fisher, Fundamentals of Solidification, 4th edition, Cambridge University press, 1996 (photolithographic copies on reserve in SST / Course center): [2] TAKAMICHI IIDA and RODERICK I. L. GUTHRIE, The physical properties of liquid metals. [3] Stephen H. DAVIS, Theory of Solidification, Cambridge university Press, 2001 [4] SOLIDIFICATION, J.A. Dantzig and M. Rappaz
* English Resources	REFERENCE /TEXTBOOK: [1] W. Kurz, D. J. Fisher, Fundamentals of Solidification, 4th edition, Cambridge University press, 1996 (photolithographic copies on reserve in SST / Course center): [2] TAKAMICHI IIDA and RODERICK I. L. GUTHRIE, The physical properties of liquid metals. [3] Stephen H. DAVIS, Theory of Solidification, Cambridge university Press, 2001 [4] SOLIDIFICATION, J.A. Dantzig and M. Rappaz
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