MSE 7420 SOLIDIFICATION PROCESSING

Offered at GTL and live on the Atlanta Campus through Distance Learning*

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WHY TAKE SOLIDIFICATION? :

Solidification plays a major role in many processes that are used in a variety of fields of engineering. For example, metals are usually continuously cast and later homogenized, hot worked to eliminate porosity that is deleterious to the final properties of the structure. Sometimes the ingots are recast in sand mold, permanent mold or in the form of precision castings. Furthermore, to build an engineering structure parts need to be joined by welding and brazing. Recently, value added manufacturing incorporating 3-D printing has been introduced to the solidification processing titanium and aluminum alloys and the microstructures developed are once again controlled by solidification effects. At the other extreme, semiconductor materials like silicon which must be purified by techniques such as zone refining and then pulled as a single crystal from the melt require an understanding of solidification.

WHO SHOULD TAKE SOLIDIFICATION? :

Because solidification is an important first step in many industrial processes, engineering students should take a course in this important field. Most undergraduate programs do not offer solidification courses; therefore, a graduate course should be available to graduate students in engineering. Because of the breath of the field participants in the course will be able to tailor their interests in the field through a special topic study.

LECTURES:

The lectures follow the material presented in the text, on the power point slides on T-Square and along with selected readings posted on T-square.

Learning Objectives:

To apply the concepts of thermodynamics and kinetics that describes the evolution of microstructure during solidification. The relationship between as-solidified microstructure and properties will be stressed throughout the course. The emphasis of the course will be on the application of fundamental principles of solidification to practical problems with manufacturing processes.

HOMEWORK:

Homework will be regularly assigned **but not collected.** The solutions to the homework will be used to motivate class discussions.

EXAMINATION AND FINAL REPORT:

There will be one in-class, closed book examinations during the semester (30% of the grade) and a final research paper (70% of the grade) that focuses on a field of interest conducted by each student.

***To assist learning on the Atlanta campus a senior TA who has taken the course will assist with answering questions. For specific questions skype can be used as well as the chat option on T-Square.**

CATOLOG DESCRIPTION:
MSE 7420 Solidification Processing

Credits (3-0-3)

PREREQUISITES: Graduate standing and an undergraduate course in thermodynamics.

TEXT: W. Kurz and D.J. Fisher, Fundamentals of Solidification, Fourth Edition, Trans Tech Publications, 1998.
References will be provided to supplement the text, lecture notes and lectures.

TOPICS:
Local equilibrium applied to the solid/liquid (S/L) interface, nucleation kinetics, atomic structure at the S/L interface, models of plane front solidification, solute segregation, ingot homogenization, morphological instability, dendrite growth and scaling laws, rapid solidification, and eutectic solidification. The application of solidification to undustry.

Week	Topics
1	The meaning of local equilibrium and the use of phase diagrams to describe local equilibrium
2	Nucleation kinetics applied to the solidification process
3	Atomic structure at the S/L interface
4-5	Models of plane front solidification, constitutional supercooling and microsegregation and the homogenization of ingot structures
6	Macrosegregation and its impact on properties
7	Morphological instability and dendrite growth and scaling laws
8	Rapid solidification- the refinement of ingot structure and metallic glasses
9	Eutectic solidification and development of *in situ* composites
10-15	Application of the principles of solidification to industrial processes: Lost wax process and it applications to the gas turbine industry Zone refining process to control impurities- application to the semiconductor industry Production of low quality, low cost polycrystalline silicon and high quality, high cost silicon single crystals and the Czochralski technique The application of solidification principles to techniques of joining 3-D printing and solidification processing