

2015 Fall

“Phase Equilibria *in* Materials”

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Introduction

- **Web lecture assistance: <http://etl.snu.ac.kr>**
 - **All materials will be posted at the webpage.**
 - **text message will be sent for the important and urgent notice.**
- **Hand out copied materials or scanned materials in website**

Text: A. PRINCE, "Alloy Phase Equilibria",

Elsevier publishing company (1966)_an out-of-printed book

Prerequisite coursework: Thermodynamics, Phase transformation in Materials

References: 1) "Phase Diagrams in Metallurgy",

Frederick N. Rhines, McGraw-Hill Book Company, INC (1956)

2) **"Principles of Phase Diagrams in Materials Systems",**

Paul Gordon, McGraw-Hill Book Company, INC (1968)

3) **"Phase Transformations in Metals and Alloys",**

D.A. Porter and K.E. Eastering, Nelson thornes Ltd (2001)

Additional reading materials will be provided.

Course Goals

This course provides the fundamental concepts and advanced understandings of phase equilibria in materials, including relationship of free energy to phase diagram. The course will address some kinetic and non-equilibrium concepts and some phenomenological discussions. In particular, phase and composition determinations in ternary and quaternary systems, relationship between phase diagrams and thermodynamic data, and cooling paths during cooling of the ternary melts will be covered. This course can provide a working knowledge of how to construct and read phase diagrams and use them to solve problems involving materials and process design.

Schedule

- week 1 Introductory Thermodynamics
- week 2 Thermodynamics of Solutions
- week 3 Binary Phase Diagrams: Two-phase Equilibrium
- week 4 Binary Phase Diagrams: Three-phase Equilibrium
- week 5 Binary Phase Diagrams: Limited Solubility in Both the Liquid and Solid State
- week 6 Binary Phase Diagrams: Reactions in the Solid State
- week 7 Binary Phase Diagrams: Allotropy of the Components
- week 8 Ternary Phase Diagrams: Two-phase Equilibrium
- week 9 Ternary Phase Diagrams: Three-phase Equilibrium
- week 10 Ternary Phase Diagrams: Four-phase Equilibrium
- week 11 Ternary Phase Diagrams: Intermediate Phases
- week 12 Ternary Phase Diagrams: Liquid Immiscibility
- week 13 Ternary Phase Diagrams: Four-phase Equilibrium Involving Allotropy of One Component
- week 14 The Association of Phase Regions
- week 15 Quaternary Phase Diagrams I
- week 16 Quaternary Phase Diagrams II

Components of Your Grade:

1) Exams (mid: 30% + final: 35%)

There will be two exams, each of which takes place in class for 2 hours. The exams will be conceptual and difficult.

2) Reports and Presentation (15%)

Assignments handed in after the start of class lose credit depending on the timing. If you wish, you may work together on homework assignments. But, you must hand in your own work, in your own words.

3) Quiz (10%) and attendance (10%)

There will be a few short quizzes among the major exams. These will take place in class and early for 20 minutes.

REMARK: The percentage can be changed under 5%.

Policies and Procedures

- ***All homework are due by the start of class on the stated deadline.***
 - Late assignments go to my office. If I'm not around, slide it under my door and leave me an email so that I know when you turned it in.
 - You lose 20% of the full assignment value per day late. Since homework are due on Wednesday, you can get 80% credit if you turn it in on **Friday**, 50% on next Monday, nothing thereafter.
- ***If you wish, you may work together on homework assignments. BUT, you must hand in your own work, in your own words.***
- **IMPORTANT:** ***you MUST reference your sources appropriately, including texts, journals web sites, etc.***
 - Article authors, title, journal, volume, year, pages
 - Book authors, title, publisher, year, pages
 - Web address
 - etc.

Microstructure-Properties Relationships

*Alloy design &
Processing*

Performance

“Phase Transformation”

Microstructure
down to atomic scale

Properties

“Tailor-made Materials Design”

Important!!!

Understanding and Controlling
Phase Transformation of Materials

Contents in Phase Transformation

D.A. Porter and K.E. Eastering, "Phase Transformations in Metals and Alloys"

Basic concept
for understanding
Phase Transformation

(Ch1) **Thermodynamics** and Phase Diagram

(Ch2) **Diffusion: Kinetics**

(Ch3) **Crystal Interface and Microstructure**

Representative
Phase Transformation

(Ch4) **Solidification: Liquid → Solid**

(Ch5) **Diffusional Transformations in Solids: Solid → Solid**

(Ch6) **Diffusionless Transformations: Solid → Solid**

Phase Equilibria in Materials

Thermodynamics

Phase diagrams

Binary, Ternary, Quarternary phase diagram