

Department of Materials Science and Engineering
MSE 305 Materials Science & Engineering
Phase Equilibria (4 credits)

Catalog Description:

Phase equilibria in ceramic and metal systems of one, two and three components. Use and determination of phase equilibrium diagrams.

Prerequisites:

Junior level standing in Materials Science and Engineering, chemistry, thermodynamics, ENG 170

Textbooks and other required materials:

Textbook:

Phase Equilibria in Ceramic Systems, F. A. Hummel, Marcel Dekker, 1984

Reading book:

Phase Diagrams in Metallurgy, F. N. Rhines, McGraw-Hill Book Comp., 1956

Course objectives:

1. Gaining of fundamental knowledge in phase relationships.
2. Learning how to use and understand the phase diagrams in ceramic and metal systems.
3. Constructing three-dimensional ternary phase diagrams from two-dimensional projections.
4. Working on a team and improving technical writing skills by reporting the experimental results.

Topics Covered:

Introduction to thermodynamic fundamentals governing phase equilibria

Equilibrium and transformation kinetics: the condition of equilibrium, homogeneous and heterogeneous equilibrium, kinetics of phase transformations, nonequilibrium

The Phase rule: definitions, formula of the phase rule, LeChatelier's principle and Clausius-Clapeyron equation

One component systems: temperature-pressure-free energy diagram; the vaporization, sublimation, fusion and transformation curve, the one component system, polymorphism.

Binary systems without solid solution: the temperature-composition diagram, simple eutectic binaries, congruently- and incongruently-melting compounds, binary liquid immiscibilities, nonequilibrium

Binary systems with solid solution: solid solution, complete solid solubility, incomplete solid solubility, compounds and solid solutions, solid solutions and solid reactions

Ternary systems without solid solutions: phase relationships in simple eutectic ternary systems; alkemade lines, boundary curves, and invariant points; crystallization paths, multiple liquid phases

Ternary systems with solid solutions: solid solution between two components only, complete solid solution between all three components, partial solid miscibility between components, polymorphism

Experimental techniques:

Independent student projects on three-dimensional ternary systems: Construct a three-dimensional space diagram of a materials system, write an extensive report, give a presentation of the work in class.

Class Schedule:

Three, one hour lectures and one hour quiz section per week.

Contribution of course to meet the professional component:

This course introduces to the fundamentals and applications of phase equilibria to the students and includes hands-on team projects to gain practical and professional experience.

Contribution of course to program objectives:

This course provides the students fundamental understanding of phase equilibria which are applied in ceramic and metal systems. The students gain experience in functioning on a team, in oral and written communication as well as in solving of ceramic and metal engineering problems in research or manufacturing environment.

Prepared by:
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