

Department of Materials Science and Engineering
CER E 470 Ceramic Engineering
Refractories (3 Credits)

Catalog Description:

Chemical and mineralogical composition; processing methods; thermal, physical and chemical properties and tests; application in high-temperature processes. Offered: Sp

Prerequisites:

Knowledge of ceramic raw materials and chemical thermodynamics.

Textbooks and other required materials:

The textbook, "Refractories," by F. H. Norton (reprinted by Ceramic Book & Literature Service, Marenta, Ohio) is required. The recommended references include: "Handbook of Industrial Refractories Technology," by S. C. Carniglia and G. L. Barna (Noyes Publishing, New Jersey, 1992) and "Introduction to Ceramics," by W. D. Kingery, D. R. Uhlman and H. K. Bowen (John Wiley & Sons, Inc., New York, 1976).

Course objectives: The students will be able to

1. Describe chemical composition of refractory materials.
2. Describe mineralogical constitution of refractory materials.
3. Discuss stability: metal/refractory reactions; slag/refractory interaction; effect of load and temperature on the dimensions of refractory in use.
4. Evaluate processing methods.
5. Analyze thermal, physical and chemical properties; testing of refractories.
6. Evaluate industrial applications of refractories.
7. Design monolithic refractories.
8. Evaluate oxide/graphite composites; sialons and related high-temperature ceramic materials.
9. Recommend uses for carbon and graphite.
10. Describe recent trends in the manufacture of refractories.

Topics Covered:

Introduction: definition of refractoriness and other terms

Physical Characterization

Porosity, surface area and permeability

Thermal properties

Mechanical properties

Chemical Stability and Characterization

Phases and their compositions at equilibrium

Gibbs triangle

Thermodynamics and reaction kinetics

Multi-component phase diagrams
Processing: Raw materials for traditional refractories
Clays, silicates
Aluminates and magnesia (magnesite, dolomite) materials
Super refractories: Processing
Oxides
Carbides
Nitrides
Refractories in the modern ferrous industry
Refractories in the nonferrous metal industry
Refractories in the glass industry: Fusion-cast products
Carbon and graphite composites
Refractories in the microelectronics industry
Engine and fuel-cell applications: Special ceramics
Advanced heat-insulation materials
Refractory metals
Refractory manufacture: Recent trends

Class Schedule:

Three, one-hour lectures weekly
Quiz sections: None

Contribution of the course to meeting the professional component:

This course provides a comprehensive treatment of refractories – raw materials, characterization, processing, and practical applications. Students receive critical knowledge relative to containment of materials under extremely demanding environments – such as high-temperatures, corroding fluids, high-stress, and so forth. It will be noted that it is the only course of its kind available to students in geological sciences and materials science and engineering.

Contribution of course to program objectives:

This senior-level undergraduate course prepares the students for careers in refractories and special ceramics industries. It occupies a very critical position in the program – serving the needs of pyrometallurgical and nuclear fields in addition to the traditional glass and ceramics communities. The course has design-component, which makes it worthwhile addition to student's program.

Prepared by:

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