ORT Braude College
Department of Mechanical Engineering

Spring 2020

Course name: Ceramic Materials
Credit Points: 3
Course structure: Lectures - 2 hrs.
Tutorial - 1 hr.
Prerequisites by course: 22400 - Materials Engineering
Prerequisites by topic: 1. Basic knowledge of thermodynamics
2. Elementary crystallography and crystal structure
3. Mechanical behavior of materials

Course description

The course will provide an overview of the basic structures, properties, processing, and applications of ceramic materials. The primary objective of the course is to explore how the structure and bonding of ceramic materials influence their properties, behavior and processing requirements. The fundamental role of point defects and stoichiometry on the properties of ceramics will be discussed. Mechanical, transport, electrical and optical properties will be explored. The critical role of flaws on the mechanical behavior of ceramics will be addressed.

Topics covered

1. Structure of ceramics: ionic and covalent bonding, Pauling's rules, ceramic crystal structures, amorphous materials (network formers, modifiers and intermediate oxides).
2. Atomic defects: including intrinsic and extrinsic point defects, Kröger-Vink notation, defect reactions
3. Phase equilibria in binary and ternary ceramic systems
4. Processing of ceramics and microstructure development: solid-state sintering, densification versus coarsening processes, grain boundary mobility, porosity evolution (stability/entrapment), viscous densification, liquid-phase sintering, constrained sintering, processing and shaping of glass
5. Mechanical properties: strength, toughness, statistical nature of ceramics failure, toughening by microstructural design
6. Thermal properties: heat capacity, thermal conductivity, thermal expansion, creep and thermal stresses
7. Electrical and optical properties: ceramic semiconductors, ionic conductors, piezo- and ferroelectrics, transparent ceramics.

Course grading:

Homework assignments:	35%
Final exam:	65%

Textbooks:

1. Carter, C.B. and Norton, M.G. *Ceramic Materials: Science and Engineering*, 2nd Ed., Springer (2013).
2. Richerson, D.W. *Modern Ceramic Engineering: Properties, Processing, and Use in Design*, 3rd Edition, Taylor&Francis (2005)
3. Green, D.J. *An Introduction to the Mechanical Properties of Ceramics*, Cambridge University Press (1998)

Course Outcomes:

- The student will develop a knowledge of the crystal structures of a wide range of ceramic materials
- The student will be able to derive ionic structures based on filling of close-packed anions
- Given a ceramic component, the student will be able to calculate its intrinsic and extrinsic defect populations
- The student will develop a knowledge of properties of ceramics and glasses and their structural origin
- The student will become familiar with the fundamental principles of ceramics and glasses processing.