

CERAMICS, GLASS AND REFRACTORIES

DR KASSIM AL-JOUBORY
UNIVERSITY OF TECHNOLOGY
BAGHDAD - IRAQ

SYLLABUS

1) Introduction,

Material Properties and Atom Arrangement, General Properties of Ceramics, Classification of Ceramics, Areas of Applications, Structure, Ceramic Bonds, Type of Bonds,

2) Materials structure

Ceramic Bonds, Ionic Ceramics, Packing of Ions, Simple Cubic Structure, FCC Structure: NaCl, FCC Structure: Zn Blend-ZnS, Hexagonal Closed Packed HCP: Corundum (Al_2O_3), Crystalline Structure of Perovskite. Covalent Ceramics, Structure of Silicates, Meta Silicates (Ring and Chain Structure), Sheet or Layer Structure, Three Dimensional Silicates.

3) Glass constituents and Properties

Glass, Constituents of Glasses , Properties of Glasses, :Type of glasses, Thermal tempering of glass Behaviour of glass during solidification Crystalline Materials

4) Raw Materials

Naturally Occurring Minerals, Iraqi Minerals, Silicates, Clay, Mica, Mullite,

Synthetic Minerals – Technical Ceramic Raw Minerals:

Oxides: Alumina, Magnesia, Zirconia, Titania

Non Oxides: Silicon Carbides, Silicon Nitrides, Titanium Carbides, Boron Carbides, Boron Nitrides.

5) Ceramic Powders

Ceramic Powder Preparation, Types of Particles,
Powder Requirements for High Quality Ceramic Microstructures
Preconsolidation and Additives

6) Properties of Ceramics

Density, Melting Behaviour

Thermal Properties: Thermal Conductivity, Coefficient of Thermal Expansion, Specific Heat, Thermal Shock resistance.

Electrical Properties: Insulators, Capacitors, Semiconductors, Piezoelectrics

Magnetic Properties

Optical Properties

Mechanical Properties: Elasticity, Young Modulus, Shear Modulus, Brittle Fracture, Plastic Deformation, Yield Point, The Reasons That Ceramics are So Brittle, Mechanical Behaviour, Porosity, Low of Mixture, Modulus of Rupture (MOR), 3-Point Bend, 4-Point Bend, Hardness, Creep, Factors Affecting the Mechanical Properties of Ceramics.

7) Shape Forming Processes

Uniaxial die Pressing, Hot Pressing, Isostatic Pressing: Cold Isostatic Pressing, Hot Isostatic Pressing, Slurry Infiltration (Slip Casting), Dispersion of Ceramic Powder, Tape Casting , Injection Molding, Extrusion, Shaping Glass: Casting or Moulding, Glass Blowing, Drawing, Spinning.

8) Densification and Sintering

Sintering, (firing), Important Variables in the Sintering Process, Types of Sintering: Vitrification, Liquid Phase Sintering, Solid State Sintering, Surface Energy, Contact Angles: Solid-Liquid Wetting, Solid-Solid (Grain Boundaries), Sintering Mechanism Driving Force for Sintering, Spark Plasma Sintering.

9) Composites

Composite Materials, Classification of Composites: Based on Matrix, Based on Reinforcing Materials, Design with Composites, Possible Advantages.

10) Refractories

Refractories, Desired Characteristics of Refractories, Classification of Refractories by their Chemical nature, Classification of Refractories by Their Physical Properties: 1) Refractoriness, Pyrometric Cone Equivalent (PCE) Measurement, Why PCE test 2) Porosity: Disadvantages of High Porosity Refractories, Advantages of High Porosity Refractories, 3) Thermal Spalling, 4) Dimensional Stability: Reversible Dimensional Changes, Irreversible Dimensional Changes, 5) Strength, Physical Form, General Method of Manufacture of Refractory Bricks: Graded Powder Preparation, Forming and Final Product.

Books

1) Fundamentals of Ceramics – Barsoum, 2) Ceramic Materials, Science & Engineering – C. Carter & M. Norton, 3) Modern Ceramic Engineering 2nd Edition – David Richerson, 4) Elements of Ceramics - F.H Norton, 5) Introduction to Ceramics - W.D Kingery, 6) Smith - Materials Science, 7) Industrial Ceramics - Singer & Singer,