

C7780

Inorganic Materials Chemistry
Doc. RNDr. Jiří Pinkas, Ph.D.

1. Introduction

Materials Science, Materials Engineering, Materials Chemistry
Chemical Compounds versus Materials Structure, Properties, Function
Traditional Materials: Ceramics, Polymers, Metals
New Materials: Composites, Semiconductors, Biomaterials, Hybrid Materials
Size Domains, Shape Fabrication
Chemical Synthesis of Materials

2. Basic Structural Chemistry

Basic Inorganic Structure Types
Metals, sc, ccp (fcc), hcp, bcc
Ionic and Covalent Compounds, CsCl, NaCl, Cubic and Hexagonal Diamond, Sphalerite, Wurtzite, NiAs, WC, CaF₂, Rutile, SiO₂, BiF₃, ReO₃, Perovskite, Spinel, Corundum, Graphite, h-BN,
Radius Ratio, Ionicity
Physicochemical Methods of Characterization

3. Structure and Properties

Real Structure and Defects
Electronic Structure of Solids, Chemical Bonding, Band Theory
Electrical Properties, Metals, Insulators, Semiconductors, Ionic Conductors
Mechanical Properties, Elastic and Plastic Deformation, Stress-Strain, Young Modulus, Bulk Modulus, Hardness
Thermal Properties, Melting Point, Thermal Conductivity, Thermal Expansion, Materials with a Negative Thermal Expansion Coefficient
Optical, Magnetic Properties

4. Direct Reactions of Solids

Powder Mixing Method - "Heat-and-Beat"
Synthesis of Spinel, Kirkendall Ratio
Self-Sustaining Reactions, Combustion Reactions
Carbothermal Reduction
Fusion-Crystallization from Glass
Polymer Pyrolysis
Mechanochemical Synthesis
Microwave-Assisted Synthesis

5. Dry High-Pressure Methods

Coordination Number - Bond Length Paradox
Belt-Type Apparatus, Diamond Anvil
Detonation Reactions
Diamond Synthesis, Hard Materials

6. Gas Phase Reactions

Gas-Solid Reactions- Tarnishing Aerosol Routes, Spray Pyrolysis, Spray Drying
Fullerenes, Carbon Nanotubes
Gas-Gas Reactions- Flame Hydrolysis
Vapor Phase Transport

7. Liquid Phase Reactions

Precipitation / Coprecipitation, Precursor Method
Freeze-Drying, Double-Salt Precursor
Pechini and Citrate Method
Flux or Molten Salt Method, Eutectics, Acid-Base Reactions, Lux-Flood Formalism
Ionic Liquids
Non-aqueous Methods
Solution-Liquid-Solid Growth

Sonochemical Synthesis

8. Sol-Gel Methods

Sol (Colloidal Solution), Gel
Precursors and Their Syntheses
Hydrolysis, Condensation, Drying, Calcination
Spin- and Dip-Coating
Colloid Processing, Metal Salt Hydrolysis, Keggin Structures
Metal Alkoxide Hydrolysis
Aerogels, Emulsion Method, Inverse Micelles
Non-aqueous Sol-Gel Methods
Hybrid Materials
Hydrothermal and Solvothermal Synthesis
Reactor, Mineralizers, Solvents, Supercritical State

9. Zeolites, Zeolitic Materials, Primary and Secondary Building Units, Sodalite Cage, Pores and Channels, Templating, Pauling Rules, Loewenstein Rule, Mesoporous Materials
Surfactants, Micelles, Critical Packing Parameter
Liquid Crystalline Phases
Supramolecular Templating Mechanisms
XRD, TEM, Gas Adsorption
Mesoporous Silica, Metal Oxides, Metal Phosphates, Metals
Layered and Pillared Materials, Intercalation

10. Growth of Single Crystals

Czochralski/Kyropoulos Method
Stockbarger and Bridgman Methods
Zone Melting
Verneuil Fusion Flame Method
Gel Method
Solution, Flux, and Hydrothermal Methods
Electrochemical Growth
VPT

11. Synthesis of Thin Films

Chemical Vapor Deposition
Precursor Properties and Synthesis, Single-Source Precursor
Metals, Oxides, Nitrides, Semiconductors, Superconductors
Anodic Oxidation, Porous Alumina
Physical Methods, Sputtering, Vacuum Evaporation, Molecular Beam Epitaxy
Self-Assembled Monolayers
Surface Chemistry

12. Nanostructured Materials and Nanochemistry

Surface and Quantum-Size Effects
Top-Down and Bottom-Up Preparation Methods