

C7780 **Inorganic Materials Chemistry**

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Introduction

History of Materials, 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, Imaging

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,
Pauling's Rules, Radius Ratio, Ionicity
Physicochemical Methods of Characterization

Structure and Properties

Real Structure and Defects, Diffusion
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

Direct Reactions of Solids

Powder Mixing Method, Synthesis of Spinel, Kirkendall Ratio
Kinetics of Solid State Reactions, Nucleation, Growth
Self-Sustaining Reactions, Combustion Reactions
Carbothermal Reduction
Fusion-Crystallization from Glass
Polymer Pyrolysis
Mechanochemical Synthesis
Microwave-Assisted Synthesis

Dry High-Pressure Methods

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

Gas Phase Reactions

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

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
Sonochemical Synthesis

Sol-Gel Methods

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

Zeolites and Zeolitic Materials

Primary and Secondary Building Units, Sodalite Cage, Pores and Channels, Templating, Pauling Rules, Loewenstein Rule, Acidity, Shape Selectivity, Catalysis
Aluminophosphates
Reticular Chemistry, Metallo-organic Frameworks (MOF), Covalent-organic Frameworks (COF)

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 Materials

Intercalation, Layered and Pillared Materials
Graphite, Graphene, Graphene-like Materials
Zirconium Phosphates, Clay Minerals, Layered Double Hydroxides, Li Intercalation Compounds

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
Vapor Phase Transport

Synthesis of Thin Films

Surface Chemistry and Properties
Anodic Oxidation, Porous Alumina
Physical Methods, Sputtering, Vacuum Evaporation, Molecular Beam Epitaxy
Porous Silicon, Chemistry on Si-Surfaces
Self-Assembled Monolayers

Chemical Vapor Deposition and Atomic Layer Deposition

CVD process, Reactions
Precursor Properties and Synthesis, Single-Source Precursor
Metals, Oxides, Nitrides, Semiconductors, Superconductors
Atomic and Molecular Layer Deposition

Nanostructured Materials and Nanochemistry

Nanoscale Materials, Quantum dots, Nanoparticles, Nanowires, Nanorods, Nanotubes, Nanofibers, Thin films
Surface Effects
Quantum-Size Effects
Top-Down and Bottom-Up Preparation Methods

Literature:

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