C7780
Inorganic Materials Chemistry
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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

Basic Structural Chemistry
Basic Inorganic Structure Types
Metals, sc, ccp (fcc), hcp, bcc
Ionic and Covalent Compounds, CsCl, NaCl, Cubic and Hexagonal Diamond, Sphalerite, Wurzite, 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
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 - "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

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

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

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

Zeolites and Zeolitic Materials
Primary and Secondary Building Units, Sodalite Cage, Pores and Channles, 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
Metallo-organic Frameworks (MOF)

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
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

Nanostructured Materials and Nanochemistry
Nanoscopic Materials, Quantum dots, Nanoparticles, Nanowires, Nanorods, Nanotubes, Nanofibers, Thin films, Planar quantum wells
Surface Effects
Quantum-Size Effects
Top-Down and Bottom-Up Preparation Methods