ITMO University

Comprehensive Approach to Materials Synthesis

Course Workload		Assessment form (examination/ graded test/ ungraded test)
ECTS	Hours	
6	216	Exam

By the end of this course, students should be able to describe the synthesis of crystals, ceramics, nanomaterials, nanocomposites, and organic-inorganic nanomaterials using suitable synthetic methods. Students should also be able to describe sol-gel, and solid-state synthesis techniques in detail, as well as the different approaches to the fabrication of organic-inorganic nanomaterials; describe methods used for the characterisation of the physicochemical properties of (organic-inorganic) nanomaterials and nanocomposites; describe the methods of sol-gel synthesis and methods for producing sols; reproduce methods of experimental research of physical and chemical nanomaterials properties depending on their chemical and phase composition, structure and external influences; to suggest possible ways to modify the methods of experimental research and methods of using specialized equipment for testing novel nanomaterials.

Course structure:

1. Solid-state and sol-gel synthetic methods; inorganic material synthesis and solvothermal synthesis:definition, concepts, and development

1.1. Basic concepts of solid-state technology, the grinding and heating of two or more solid compounds to obtain a new solid with a well-defined structure
1.2. Chemical processes occurring during the grinding and heating and the emergence of a new structure
1.3. Basic concepts of sol-gel technology, the transition of a true solution into a sol and then into a gel
1.4. Chemical processes occurring during the formation of structured liquids-sols and a three-dimensional framework
1.5. Conditions for the processes flow in colloidal systems
1.6. Basic concepts of inorganic material synthesis, the preparation of (primarily) nonmolecular solid compounds in soid, liquid, and gas phase reactions
1.7. Physical and chemical processes occurring during deposition

2. Mathematical objects of complex structures: sols, gels, and xerogels

2.1. Consideration of the structure and formation of inorganic and organic-inorganic nanomaterials

3. Nanomaterial fabrication

3.1. Basic concepts of nanomaterials and the quantum effect
3.2. Top-down approach to nanomaterial fabrication
3.3. Bottom-up approach to nanomaterial fabrication

4. Practical application of nanosystems

4.1. Application of nanomaterials in science and medicine
4.2. Sol-gel, solid-state, and solvothermal synthetic methods for the fabrication of hydrophobic powders, films, and transparent coatings
4.3. Inorganic material synthesis for the development of functional materials