[Title]			[Instructor]		
Advanced Inorganic Materials Chemistry			Hideto Sakane／Naoya Miyajima		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA701	2	Energy Materials Science Course	1st Semester	Mon.／IV	Japanese

[Outline and purpose]

As a local structural analysis method for inorganic materials XAFS is lectured from basic principles to applications.
As an example of inorganic materials and industrial design and structural control of them, carbon material is also lectured in its science and applications.
This lecture aims to learn research and development of characters and characterization for wide range of inorganic materials.

[Objectives]

Students are expected to apply the knowledges learned to characteristics design and analysis of a variety of inorganic materials.

[Requirements]

Expertise of solid-state chemistry, molecular structure, and spectroscopies.

[Evaluation]

Report on the considerations of the lecture and student's own research problems.

[Textbooks]

none

[References]

Students are wanted to select themselves proper references.

[Schedule]

1. Interferences of X-ray and materials
2. Analytical methods for materials utilizing X-ray
3. Core shell of atomic orbitals
4. Absorptions of X-ray
5. Basic principles of XAFS (X-ray Absorption Fine Structure)
6. Analysis of XAFS
7. Measurements of XAFS
8. Applications of XAFS
9. Basic structures of carbon materials
10. Preparations of carbon materials (carbonizations and graphitization)
11. Chemical properties of carbon materials
12. Surface and spatial properties of carbon materials
13. Diversity of carbon materials
14. Applications of carbon materials
15. Reports

[Title]			[Instructor]		
Advanced Course of Inorganic Material Property			Satoshi Wada / Shintaro Ueno		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA702	2	Energy Materials Science Course	2nd Semester	Mon./II	Japanese/ English

[Outline and purpose]

Students learn the basics and characteristics of inorganic materials, dielectrics, piezoelectrics and optical materials, and their applications. Students also try to understand the relationship between the unique microstructures of these materials and physical properties, and the essence of material design.

[Objectives]

Students can explain the fundamentals and principles of electronic and optical properties of inorganic materials, and also explain the origins of physical properties of materials and physical phenomena.

[Requirements]

A good grounding in Physical Chemistry, Inorganic Chemistry, and Quantum Chemistry.

[Evaluation]

1. examination 45%
2. examination [midterm] 30%
3. term papers 25%

[Textbooks]

Lecture slides will be provided.

[References]

[Schedule]

1. Introduction
2. The essence of electronic structures and crystal structures
3. Mechanism of electric polarization
4. Complex dielectric constant and dielectric relaxation, Evaluation of dielectric properties
5. Ferroelectrics and ferroelectric domain configuration
6. Application of dielectrics and ferroelectrics
7. Piezoelectricity and pyroelectricity
8. Midterm examination
9. Characteristics of electromagnetic waves and refraction
10. Light scattering and light absorption of materials
11. Mechanisms of luminescence, luminescent materials and applications
12. Characteristics of LASER, LASER materials and applications
13. Metal oxide nanoparticles and optical applications
14. Wet processes for material design
15. Examination and term paper submission

[Title]			[Instructor]		
Advanced Course of Functional Organic Molecular Chemistry			Tetsuo Kuwabara / Naoki Yoneyama		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA703	2	Energy Materials Science Course	1st Semester	Tue.／II	Japanese/ English

[Outline and purpose]

Functional organic molecules with unconventional physical and chemical properties have been widely used in the field of electronic devices and medical treatments. They are one of the most important advanced technologies now and in the future. In the present lecture, the students will learn the basic acknowledgment and application of the functional organic molecules.

[Objectives]

The students will learn the leading edge to design the molecular structure of the functional organics and to measure the physical and chemical properties.

[Requirements]

The students will need to have a basic understanding of organic chemistry, crystal chemistry, and chemical bond theory. It is very fine to be interested in the supermolecular chemistry and/or solid state chemistry.

[Evaluation]

attitude 30%
documentary survey and presentation 70 %

[Textbooks]

[References]

[Schedule]

1. guidance: functional organic molecules from the view of material science
2. biomimetic materials
3. supermolecule and molecular recognition
4. self-assembly and molecular aggregation
5. rotaxane, catenane and molecular machines
6. knots and dendrimers
7. analysis and sensing of nanostructures
8. interim evaluation
9. molecular based organic conductors
10. synthesis and crystal structure of organic conductors
11. electronic structure of organic conductors
12. how to measure the electronic properties of organic conductors
13. physics and chemistry in strongly correlated electron system
14. physical properties of organic superconductors
15. summary and comprehensive evaluation

[Title]			[Instructor]		
Advanced Chemical Analysis			Ikuo Ueta / Kumi Inoue		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA704	2	Energy Materials Science Course	1st Semester	Wed.／I	Japanese/ English

[Outline and purpose]

This lecture presents the analytical methods using chromatography and biosensing for highly sensitive and specific quantification of organic compounds including bioactive molecules.

[Objectives]

Understanding the theory and recent progresses on chromatography in specially HPLC, and Gas chromatography, as well as on biosensors and biosensing especially using electrochemical methods.

[Requirements]

Basic knowledge of chromatography and biosensing for spectrometric identification of organic compounds.

[Evaluation]

By report on the considerations of the lecture associated with chromatography and biosensing.

[Textbooks]

None

[References]

None

[Schedule]

. Basic theory of HPLC
2. Modern separation in HPLC (1)
3. Modern separation in HPLC (2)
4. Modern detection in HPLC
5. Gas chromatography (1)
6. Gas chromatography (2)
7. Modern sample preparation in chromatography (1)
8. Modern sample preparation in chromatography (2)
9. Basic theory of biosensors
10. Recent progress on biosensors (1)
11. Recent progress on biosensors (2)
12. Electrochemical biosensors (history and theory).
13. Recent progress on electrochemical biosensors (1)
14. Recent progress on electrochemical biosensors (2)
15. Application of biosensors for bioimaging.

[Title]			[Instructor]		
Advanced Course of Polymer Materials Chemistry			Hidenori Okuzaki / Makoto Obata		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA705	2	Energy Materials Science Course	2nd Semester	Thu.／II	English/Japanese

[Outline and purpose]

This course addresses the relation between structures and basis properties of various polymer materials, and their evaluation methods.

[Objectives]

To understand the relation between properties and structure of polymer materials.

[Requirements]

Basic knowledge of polymer synthesis and material properties.

[Evaluation]

Homework/Reports 70%
Class participation 30%

[Textbooks]

[References]

高分子化学序論，化学同人
高分子と複合材料の力学的性質
高分子のＸ線回折（上・下）

[Schedule]

1. Introduction
2. Polymer synthesis
3. Molecular weight and polydispersity
4. Glass transition
5. Conformation and configuration
6. Creep and relaxation
7. Theoretical model
8. Stress-strain curve, Young’s modulus, strength, and elongation at break
9. Theoretical modulus and strength
10. Crystalline polymer
11. Amorphous polymer
12. Wide-angle X-ray diffraction and crystallinity
13. Dynamic mechanical properties and viscoelasticity
14. Drawing of polymer materials
15. Molecular orientation

[Title]			[Instructor]		
Material Chemistry of Solids			Satoshi Watauchi / Yoshinori Yonesaki / Masanori Nagao		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA707	2	Energy Materials Science Course	2nd Semester	Tue.／II	Japanese

[Outline and purpose]

For a better understanding of material properties, an elementary knowledge of group representation theory is lectured. For a better understanding of material preparation, crystal nucleation theory is lectured.

[Objectives]

To explain the influence of an electrostatic field symmetry on the energy shift of ion from the viewpoint of group representation theory. To understand the effects of thermodynamic parameters such as pressure and temperature on crystal nucleation phenomena.

[Requirements]

Basic knowledge of symmetry classification of molecular by sets of symmetry operations and on thermodynamics (lectured in Structure and Chemistry of Crystalline Solids).

[Evaluation]

Midterm examination: 50%
Term-end examination: 50%

[Textbooks]

[References]

[Schedule]

1 Application of group theory to crystallography
2 Sets, Group
3 Crystallographic point groups
4 Representation matrices
5 Irreducible representations
6 Crystal field theory
7 Midterm examination
8 Midterm summary
9 Phase equilibrium
10 Crystal structure and atomic arrangement on a crystal surface
11 Nucleation
12 Surface energy
13 Equilibrium form of crystal
14 Principle of crystal growth
15 Total summary

[Title]			[Instructor]		
Advanced Quantum Materials Chemistry			Tetsuya Sato		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA708	2	Energy Materials Science Course	1nd Semester	Thu.／I	Japanese/English

[Outline and purpose]

Nano-level structure control technology combining nanoscience and nanotechnology is required for creation of high-definition and high-performance materials to be the basis of next-generation electronics and photonics. We will explain how to control chemical reaction at the atomic / molecular level and create quantum dots and extremely thin films. Lecture on characteristics and physical properties of devices and photonics materials making use of quantum effect. Learn the process theory to grasp the thin film · surface from a micro viewpoint of atoms / molecules and create a new inorganic material by physical and chemical methods. In addition, we will acquire molecular element / quantum device design method based on numerical analysis.

[Objectives]

1. To understand the electronic excitation and chemical reaction of the solid surface.
2. To understand nanostructure creation method using plasma / process principle.
3. To understand how to create energy related materials using quantum effects.
4. To understand understanding quantum chemistry of molecules.
5. To understand the principles and preparation methods of semiconductor thin films.

[Requirements]

Physical Chemistry, Quantum Chemistry

[Evaluation]

examination：0 %
homework ：40 %
audit attitude：40 %
presentation：20 %

[Textbooks]

[References]

[Schedule]

1. Electronic excitation of the surface I
2. Electronic excitation of the surface II
3. Electron excitation of solid surface by slow electron / photo excitation I
4. Electron excitation of solid surface by slow electron / photo excitation II
5. Collision of slow ion and solid I
6. Collision of slow ion and solid II
7. Surface chemical reactions involving hydrogen atoms and radicals I
8. Surface chemical reactions involving hydrogen atoms and radicals II
9. Quantum device fabrication I
10. Quantum device fabrication II
11. Quantum chemistry of molecules I
12. Quantum chemistry of molecules II
13. Fabrication of thin films and nanostructure using plasma processes I
14. Fabrication of thin films and nanostructure using plasma processes II
15. Characterization of thin films and nanostructure.

[Title]			[Instructor]		
Advanced Course of Solid-State Electronic Materials			Hiroshi Yanagi / Ichiro Fujii		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA709	2	Energy Materials Science Course	1st Semester	Tue.／I	Japanese / English

[Outline and purpose]

Students learn the following topics:
1. Electronic structure of solids and devices in related chemistry of solid
2. Sintering mechanisms for electric ceramics such as dielectrics

[Objectives]

To understand basics and application of electronic chemistry of solids and its evaluation techniques, and to understand and explain sintering methods used for the fabrication of electric ceramics

[Requirements]

A good grounding in Physical Chemistry, Inorganic Chemistry, and Quantum Chemistry.

[Evaluation]

Quizzes and Examinations 50%
Attendance and class participation 50%

[Textbooks]

[References]

Suk-Joong L. Kang, "Sintering: Densification, Grain Growth and Microstructure", Elsevier, 2005. ISBN: 9780080973074

[Schedule]

1. Introduction
2. The electronic structure in solids
3. Spectrophotometric analysis (Basic)
4. Spectrophotometric analysis (Advanced)
5. The basics of functional transparent oxides
6. Film preparation and evaluation techniques
7. Application in actual devices
8. Summarization and Examination
9. Basic of sintering and development of microstructure
10. Thermodynamics of sintering
11. Sintering models and densification
12. Grain growth
13. Sintering aids and defect chemistry
14. Topics: fabrication of multilayer ceramic capacitors
15. Summarization and Examination

This schedule may be changed by an arrangement between instructors and students.

[Title]			[Instructor]		
Advanced Course in Crystal Science and Engineering			Yoichi Nabetani / Tsutomu Muranaka		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTB701	2	Energy Materials Science Course	1nd Semester	Mon.／II	Japanese /English

[Outline and purpose]

Crystal science and engineering is a key technology for semiconductor devices used in various optical and electronic applications. This course provides the knowledge of fabrication and characterization of semiconductor quantum nanostructures. You will learn up-to-date information about fabrication and characterization of semiconductor quantum nanostructures from R&D phase to industrial product phase.

[Objectives]

By the end of the course, you will be able to understand and describe fabrication and characterization of semiconductor quantum nanostructures. Also you will be able to understand and describe many kinds of technology for semiconductor quantum nanostructures in today's world.

[Requirements]

Electromagnetism, quantum mechanics and semiconductor physics.

[Evaluation]

Activities, lectures, discussions and presentations: 100%

[Textbooks]

Original text will be used.

[References]

Simon M. Sze, Kwok K. Ng, Physics of Semiconductor Devices, Third Edition, Wiley-Interscience (ISBN:978-0471143239)

[Schedule]

1. Electrical properties of semiconductors
2. Optical properties of semiconductors
3. Magnetic properties of semiconductors
4. Structural properties of semiconductors
5. Fabrication processes of semiconductor quantum nanostructures
6. Characterization: Structural properties of semiconductor quantum nanostructures
7. Characterization: Optical and electrical properties of semiconductor quantum nanostructures
8. Device applications of semiconductor quantum nanostructures

This schedule may be changed by an arrangement between instructors and students.

[Title]			[Instructor]		
Quantum Electronic Device Engineering			Ichiro Shiraki/Kaoru Ijima/ Kazuharu Uchiyama		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTB703	2	Energy Materials Science Course	2nd Semester	Thu.／I	Japanese

[Outline and purpose]

The latest electronic devices are highly advanced and often cannot be understood without thinking in a quantum theory. Under these circumstances, for understanding typical device principles, the quantum mechanical phenomena used in the latest quantum devices and the physics behind them will be lectured.

[Objectives]

Understand the basics of quantum mechanics and be able to explain the principles of devices.
Understand the basics of quantum electromagnetic fields.

[Requirements]

Basic knowledge of field concepts and quantum mechanics are required.

[Evaluation]

Report assignment

[Textbooks]

[References]

[Schedule]

1-1 Fundamentals of quantum mechanics
- Harmonic oscillator and quantization of light field

1-2 Near-field optical interaction and its application to nanodevices

2 Examples of application of semiconductor nanostructures to devices

3 Examples of observation technologies that support quantum devices

References may be indicated as appropriate.

[Title]			[Instructor]		
Quantum Physics			Chikako Uchiyama		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTB704	2	Energy Materials Science Course	2nd Semester	Tue.／II	Japanese

[Outline and purpose]

Quantum physics provides a theoretical basis for understanding and describing microscopic phenomena. Because of its quick development towards greater densities and finer dimensions in semiconductor engineering and energetic science, quantum physics is indispensable to designing novel devices. In this course, you will learn the basics of quantum mechanics and quantum information processing.

[Objectives]

By the end of this course, you will be able to understand and explain the basic concepts of quantum mechanics, such as the Schrödinger equation, superposition, and entanglement, as well as the basic principles of quantum information processing, such as quantum cryptography, quantum computation, and quantum teleportation.

[Requirements]

[Evaluation]

Small quizzes / Reports100%

[Textbooks]

[References]

[Schedule]

1. Basics of quantum mechanics -1 (the Schrödinger equation)
2. Basics of quantum mechanics -2 (superposition, entanglement)
3. Basics of quantum mechanics -3 (spin, unitary transformation)
4. Principle of conventional cryptography
5. Principle of quantum cryptography-1
6. Basics of quantum optics
7. Principle of quantum cryptography-2
8. Quantum gates
9. Basics of quantum algorithm
10. Principle of quantum computation
11. Time evolution of a quantum system
12. Effects of decoherence on quantum information
13. Methods to overcome decoherence
14. Quantum teleportation
15. Quantum transport

[Title]			[Instructor]		
Physics for Solid State Materials			Junji Yamanaka/ Keisuke Arimoto		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTB705	2	Energy Materials Science Course	2nd Semester	Mon.／II	Japanese

[Outline and purpose]

We will learn about the basics of crystal structures and experimental techniques for analyzing crystal structures. Then, we will focus on semiconductor physics which is a core field of electronics.

[Objectives]

Introduction for Structure Analysis of Solid State Materials
Introduction for Solid State Physics

[Requirements]

Completion of course covering Quantum Mechanics
Completion of course covering Electromagnetism

[Evaluation]

Activities, lectures, and discussions: 80%
Presentations: 20%

[Textbooks]

[References]

<References written in Japanese are shown in the Japanese syllabus.>
Transmission Electron Microscopy, David B. Williams and C. Barry Carter, ISBN-10: 030645324X, ISBN-13: 978-030645324
Electronic Structure and The Properties of Solids, Walter A. Harrison, ISBN-13: 978-0-486-66021-9, ISBN-10: 0-486-66021-4

[Schedule]

1. Introduction
2. Crystal Structure
3. Diffraction Theory I
4. Diffraction Theory II
5. Transmission Electron Microscopy I
6. Transmission Electron Microscopy II
7. Other Experimental Techniques of Crystal Structure Analyses
8. Band Theory
   8.1 Nearly Free Electron Model
   8.2 Tight Binding Model
9. Band Structure
10. Transport Properties of Solids
11. Optical Properties of of Solids
12. Physics for Semiconductor Devices
   12.1 pn Junction
   12.2 MOS Devices
   12.3 Heterostructure Devices

[Title]			[Instructor]		
Advanced Quantum Science of Light and Matter			Akira Ishikawa / Masaru Sakai/ Atsushi Syouji		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTB706	2	Energy Materials Science Course	1nd Semester	Tue.／II	Japanese

[Outline and purpose]

In this course, we explain: (1) theory on the interaction between light and nano materials and optical response of nano materials; (2) optical properties in interaction between light and nanosized materials; (3) optical responses in a semiconductor microstructure on the interaction through a radiation field performed by the coherent transition radiation function. In order to realize innovative nanodevices, it is essential to understand and apply those new aspects of interaction between light and matter.

[Objectives]

1. to understand optical response of nano materials
2. to understand interaction between light and nanosized materials.
3. to understand longwave approximation and limitation of that, and transition probability of nano-scale materials.

[Requirements]

Electromagnetics, quantum mechanics, and optics.

[Evaluation]

Attendance, Attitude: 100%

[Textbooks]

None

[References]

Cho, Kikuo, Optical Response of Nanostructures, Springer-Verlag Tokyo (ISBN:4431710752)

[Schedule]

1. Classical theory of optical response (A. Ishikawa)
2. Semiclassical theory of optical response (A. Ishikawa)
3. Nonlocal response theory (A. Ishikawa)
4. Nonlocal response theory (A. Ishikawa)
5. Applications (A. Ishikawa)
6. Optical pulse propagation in exciton resonant region (M. Sakai)
7. Development of enhanced SNOM (M. Sakai)
8. Light localization in GaN nanocolumns (M. Sakai)
9. Random laser (M. Sakai)
10. WGM laser in GaN microdisk (M. Sakai)
11. Exciton polariton (A. Syouji)
12. Confined exciton (A. Syouji)
13. Longwave approximation (A. Syouji)
14. Exciton creation and annihilation (A. Syouji)
15. Radiation correction of confined exciton (A. Syouji)

[Title]			[Instructor]		
Advanced Photon Engineering			Tetuo Harimoto		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTB708	2	Energy Materials Science Course	2nd Semester	Mon.／Ⅳ	Japanese

[Outline and purpose]

Emphases of this course are on the development of ultrahigh intensity laser science and interaction of laser and materials. In addition, some numerical methods on the photon engineering, especially involving the UV laser generation using the second-harmonic generation and the optical chirped pulse parametric amplification. It meets the needs of many students with interests in the modern physics and provides students with a general feel for the subject of ultrahigh intensity laser science.

[Objectives]

To introduce students to the concept of photon and ultrahigh intensity laser science.
To introduce students to the generation mechanism of ultrashort laser pulses.
To allow students to learn the numerical method of the photon engineering.
To introduce students to the interaction of laser and materials.

[Requirements]

Electromagnetics, optics, and quantum mechanics.

[Evaluation]

Report: 80%
Attendance: 20%

[Textbooks]

[References]

Amnon Yariv, Optical Electronics, Saunders College Publishing, 1991, ISBN:0030474442
Amnon Yariv, Quantum Electronics, John Wiley & Sons Inc., 1989, ISBN:0471609978

[Schedule]

1. Generation of ultrashort and ultrahigh intensity laser pulses
2. Wavelength conversion of ultrahigh intensity laser pulses
3. Amplification of a cycle pulse
4. Measurement for ultra-broadband laser pulses
5. Design of photonics devices
6. Interaction of laser and materials
7. Simulation of photon engineering

[Title]			[Instructor]		
Advanced Course of Catalyst Design for Electrodes			Makoto Uchida / Katsuyoshi Kakinuma / Hiroshi Yano		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTC702	2	Energy Materials Science Course	2nd Semester	Wed.／I	Japanese

[Outline and purpose]

Fuel cells have attracted much attention as key technologies of energy conversion to solve the energy and global environment issues. Especially, polymer electrolyte fuel cells (PEFCs) have been intensively developed for the extensive spread as residential cogeneration systems and automotive power sources. In this course, design guideline, preparation and evaluation methods and development trend of electrocatalysts and catalyst layers with important roles in the PEFCs will be studied. Furthermore, lectures on fuel cell systems will be given, accompanied with practical science based on progressive experience in companies.

[Objectives]

To learn expert knowledge and advanced technology on electrocatalysts and catalyst layers in PEFCs, and fuel cell systems

[Requirements]

Basic knowledge on electrochemistry, physical chemistry, materials chemistry, and thermodynamics

[Evaluation]

Report and examination: 60%
Attendance: 40%

[Textbooks]

None

[References]

1.（監修）田村英雄、（編著）内田裕之、池田宏之助、岩倉千秋、高須芳雄，固体高分子形燃料電池のすべて，エヌティーエス（in Japanese)
2. 松田好晴、岩倉千秋共著，電気化学概論，丸善（in Japanese)

[Schedule]

1. Overview and significance of energy and global environmental issues
2. Electrochemistry of fuel cells (1)
3. Electrochemistry of fuel cells (2)
4. Principles and development status of various fuel cells (1)
5. Principles and development status of various fuel cells (2)
6. Design for electrocatalysts in PEFCs (1)
7. Design for electrocatalysts in PEFCs (2)
8. Design for practical electrocatalysts in PEFCs (1)
9. Design for practical electrocatalysts in PEFCs (2)
10. Design for pore structure and catalyst effectiveness of the catalyst layer in PEFCs (1)
11. Design for pore structure and catalyst effectiveness of the catalyst layer in PEFCs (2)
12. Design guideline and evaluation methods of the catalyst layer in PEFCs (1)
13. Design guideline and evaluation methods of the catalyst layer in PEFCs (2)
14. Current status and future prospects of PEFC systems
15. Summary

[Title]			[Instructor]		
Advanced Course of Engineering for Solar Energy Conversion			Hiroshi Irie / Toshihiro Takashima		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTC703	2	Energy Materials Science Course	1st Semester	Mon.／II	English／Japanese

[Outline and purpose]

A light-related system is one of the candidate technologies for sustainable energy conversion and environmental preservation. We will learn such light-related systems based on mainly physical chemistry as well as quantum chemistry and solid state physics. Students also learn the fundamental principle of standard and new concept solar cells.

[Objectives]

1. To understand the interaction of light with solids, and successive phenomena
2. To understand the fundamental principle of standard and new concept solar cells

[Requirements]

Physical Chemistry, Quantum chemistry, Solid state physics, Inorganic Chemistry, and Semiconductor Physics

[Evaluation]

1 final examination　20%
2 midterm examination　20%
3 homework / reports 20%
4 class participation / presentation 40%

[Textbooks]

[References]

魚崎浩平、米田龍、高橋誠、金子晋（共訳）：固体の電子構造と化学、技報堂出版、1989 年（in Japanese）
山口　真史・M･A･グリーン・大下　祥雄・小島　信晃，太陽電池の基礎と応用，丸善（in Japanese）
Martin A. Green, Solar Cells, University of New South Wales
Peter Wurfel，太陽電池の物理，丸善（in Japanese）
Peter Würfel, Physics of Solar Cells: From Basic Principles to Advanced Concepts, Wiley-VCH

[Schedule]

1.Introduction
2. Light energy conversion, Basic theory
3. Solar energy conversion : To chemical energy 1
4. Solar energy conversion : To chemical energy 2
5 Solar energy conversion : To hydrogen energy
6. Thermal energy conversion : Basic theory
7. Thermal energy conversion : To electricity
8. Solar cells and sunlight
9. Semiconductor properties
10. Carrier generation and recombination
11. Si based solar cells
12. Compound-semiconductor Solar cells
13. Organic solar cells
14. Future view
15. Final examination / presentation

[Title]			[Instructor]		
Advanced Course of Design for Advanced Inorganic Materials			Takahiro Takei / Nobuhiro Kumada		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTC705	2	Energy Materials Science Course	1st Semester	Tue.／II	Japanese

[Outline and purpose]

Crystal structure, crystal defects, functions and property of functional inorganic compounds are acquired as combined with scientific research fields of inorganic industrial chemistry, crystal engineering, materials engineering. Also recent topics about properties, characterization and crystal structures of functional inorganic compounds are discussed.

[Objectives]

1. to understand point group and non-stoichiometry of oxides
2. to understand drawing technique of crystal structure
3. to understand crystal chemistry
4. to understand X-ray diffraction analysis

[Requirements]

inorganic chemistry, solid state chemistry, materials engineering, physical chemistry, electronic physical properties

[Evaluation]

Homework/ examination: 70%
audit attitude: 10%
presentation: 20%

[Textbooks]

Anthony R. West, Basic Solid State Chemistry, Second Edition, John Wiley & Sons Ltd.,
ISBN: 978-1-119-94294-8

[References]

[Schedule]

1. Lattice defects and its effects on functions and properties in materials
2. Non-stoichiometry of oxides
3. Lattice defects in oxides
4. Defect concentration of lattice defects
5. Defect concentration and defect equilibrium
6. Relationship between defect concentration and electrical conductivity
7. Recent topics I
8. Interim summary
9. Basics of crystal structure
10. Analysis method of crystal structure
11. Metallic conductivity and Superconductivity
12. Semiconductivity
13. Ionic conductivity
14. Recent topics II
15. Summary

[Title]			[Instructor]		
Advanced Course of Science for Surfaces and Interfaces			Junji Inukai / Akiyoshi Kuzume / Toshihiro Miyao		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTC706	2	Energy Materials Science Course	1nd Semester	Fri.／I	Japanese

[Outline and purpose]

Comprehending basic surface crystallography, surface analytical methods, and surface reactions to be applied to students' researches

[Objectives]

Understanding basic ideas of the following topics:
1) Surface and interface science.
2) Surface crystallography at the atomic level.
3) Surface analytical methods.
4) Surface reactions on model and real surfaces.
5) Adsorption and reactions on solid surfaces.

[Requirements]

Basic knowledge on solid crystallography and quantum chemistry.

[Evaluation]

Class participation 40%
Reports, quiz, and examination 60%

[Textbooks]

[References]

Atkins' Physical Chemistry, Peter Atkins.

[Schedule]

1. Introduction
   Surface crystallography I: Single crystal surfaces
2. Surface crystallography II: Notification of surface structures; adlayers
3. Surface crystallography III: Reciprocal lattice
4. Surface crystallography IV: Reciprocal lattice to real lattice
5. Quiz on surface crystallography
6. Surface analysis method I: Electrochemistry on Single crystal surfaces
7. Surface analysis method II: Morphological study with Scanning Probe Microscopy
8. Surface analysis method III: Infrared absorption spectroscopy
9. Surface analysis method IV: Surface enhanced Raman spectroscopy
10. Quiz on surface analysis method
11. Adsorption at solid surfaces I: (interpretation of adsorption isotherms)
12. Adsorption at solid surfaces II: (surface characterization using adsorption phenomena)
13. Adsorption at solid surfaces III: (chemisorption and surface catalysis)
14. Adsorption at solid surfaces IV: (catalytic reaction mechanisms at solid surfaces)

Quiz on adsorption at solid surfaces

[Title]			[Instructor]		
Advanced Course of English for Green Energy Science and Technology, Advanced Level			D. A. Tryk / M. E. Brito		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTC707	2	Energy Materials Science Course	1nd Semester	Wed.／III	English

[Outline and purpose]

This course will cover all aspects of scientific and engineering English, including reading, writing, speaking and listening. All are important for today's green energy scientist and engineer. Oral skills are particularly important, including presentation and discussion skills. Such skills will benefit you throughout your career. There will be an emphasis on learning general chemical and engineering vocabulary, in addition to specific terms for each student's own research. The course will complement the Green Program monthly presentations.

[Objectives]

The specific achievements or milestones will include: (1) ability to read a technical paper and summarize it briefly in English; (2) ability to write a short paper; (3) ability to confidently give a short technical presentation in English and understand and answer questions; (4) ability to listen to an oral technical presentation and ask questions.

[Requirements]

D1 status

[Evaluation]

Attendance: 20%; presentations: 40%; reports: 40%

[Textbooks]

None

[References]

None

[Schedule]

1. Introduction; overview; basic pronunciation; online software; short self-introductions;
2. Self-introductions by students; online software;
3. Brief oral introduction to your research field for non-specialists 1
4. Brief oral introduction to your research field for non-specialists 2
5. Brief oral introduction to your research field for non-specialists 3
6. Brief oral introduction to your research field for non-specialists 4
7. Oral presentation of student's research 1
8. Oral presentation of student's research 2
9. Oral presentation of student's research 3
10. Oral presentation of student's research 4
11. Brief written reports on student's own research 1
12. Brief written reports on student's own research 2
13. Brief written reports on student's own research 3
14. Brief written reports on student's own research 4
15. Brief written reports on student's own research 5