Dept. of Materials Science and Engineering

The graduate school of Advanced Materials Engineering Department in Kookmin University was established in November 1974 after the authorization of Ministry of Education. The goal of our graduate course is to educate students who will become pro-active leaders with creative mind in the field of materials related industry by utilizing knowledge of materials engineering. Until now, more than 200 students with master and doctoral degrees have been produced and they play a critical role in the field of industry as well as, academia. 20 faculty members in the graduate school of Advanced Materials Engineering Department are actively doing their research works in the field of metals, ceramics, polymers, semiconductors, displays and energy/environment. Also, the department possesses many up-to-date experimental equipments for various materials-related researches.

Summary Understanding all the topics of materials science and engineering from the synthesis and characterization of metals, electronic materials, ceramics, and polymers to the development of high technology.

□ Courses

- **Thermodynamics of Materials (3)**

  This course is designed for understanding the thermodynamical behavior of solid solutions. Phase equilibria, statistical physics, chemical reactions, structures of interface and imperfection related with thermodynamic principles are discussed.

- **Mechanical Behavior of Materials (3)**

  Advanced theories of dislocation, and strengthening mechanism due to dislocations are discussed. Topics include advanced principles and applications of creep, fatigue and fracture behaviors.

- **Advanced Semiconductor Physics and Technology (3)**

  Behaviors of electrons and holes in semiconductor are discussed and their relevant p-n junction, Schottky junction, MOS capacitors and MOSFET are studied.

- **Electronic Materials (3)**

  This course is designed to achieve knowledge of principles, properties and applications of electronic materials. Topics include conductor, semiconductors, superconductors, dielectrics and ferroelectrics.

- **Phase Transformation (3)**

  Based on diffusion and chemical reaction, principles of phase transformation, solidifications, growth of crystals, precipitation, recrystallization, and Martensite

transformation are intensively and extensively discussed.

· **Engineering English Communications** (3)

-The present new course is developed for graduate students to improve communication skills, reading ability, as well as technical writing skills in English in the field of science and engineering.

· **Electronic Ceramics (3)**

Principles of various electronic ceramics are introduced and semiconducting, insulating, high dielectric, magnetic, superconducting ceramics are discussed. Applications, such as sensors, actuators, solid oxide fuel cells and MEMS are also discussed. Fracture Mechanics of Engineering Materials Based on fracture mechanics, characterization and design applications of fracture, fatigue, creep of metals are studied.

· **Polymer Science & Engineering (3)**

This course introduces the concept of structure, synthesis, physical/chemical properties of polymer materials which is one of most important characteristics for materials applications in industry. Topics include elastic and plastic theory, strengthening mechanism of polymer materials, tensile behavior, and structure.

· **Statistical Thermodynamics (3)**

Topics include ensembles, classical statistical thermodynamics, ideal gases, lattice statistics, chemical equilibrium, and reaction kinetics.

· **Electron Microscopy (3)**

This course is designed to understand and practice principles and techniques of electron microscope for metallurgical phenomena. Topics include electro optics, diffraction phenomena, analysis of diffraction pattern, kinematical theory, dynamical theory, contrast analysis, images on crystalline imperfections, and CBED analysis.

· **Surface Engineering (3)**

Advanced principles and applications of electrodeposition, chemical deposition, colouring, anodizing, spraying, chemical vapor deposition and physical vapor eposition are discussed.

· **Special Surface Modification Engineering (3)**

Study about the principle, the way of treatment, and the development trend of special surface treatment process to give new properties to material's surface.

· **Dislocations in Crystalline Solids (3)**

Topics include generation mechanisms of defects, effects of crystal structure to

dislocations, reaction between dislocation and point defect, and phenomena related to defects and their influence to materials characteristics.

· **Creep and Superplasticity (3)**

In this class, the mechanical properties of high temperature structural materials and their deformation mechanisms are studied. Topics include creep deformation, fatigue and fracture, high temperature failure, and superplastic deformation as well as stress/life prediction of materials.

· **Friction and Wear (3)**

In this course, friction and wear of engineering materials are discussed. Special topics include surface interactions, fraction, wear of lubrication, and effects of materials properties as well as development of wear resistant materials and their applications. Relevant techniques of analysis and measurement are also presented.

· **Thin Film Science and processing (3)**

The object of "Thin Film Science and Engineering" class is not only to document what is known about thin films including multilayers, but also to promote the potential of these versatile thin films and to facilitate the adsorption of the technology by others. The field introduced in this class is new. This class will show that thin films including multilayers represent a model platform for promoting modern research and furthermore, the intellectual distance between concept and application is minimal.

· **Process Integration of Integrated Circuits (3)**

This course is to provide the student with an understanding of each process for the fabrication of semiconductor devices and the process integration of Integrated Circuits. In addition, the process for 1㎛, 0.8㎛, and 0.5㎛ CMOS will be introduced, and then discussing its device characteristics. Based on the technology roadmap, the progress for the process development required for the future devices will be predicted and discussed.

· **Plasma Physics and Processing (3)**

The goal of this course if to provide the student with a sound, scientific understanding of plasma physics and plasma chemistry through which he can better use plasma processes for microelectronic fabrication. The introduction of various plasma processes for sputtering, etching, plasma enhanced chemical deposition of thin films helps him to know the main factors affecting each plasma process. In addition, vacuum technology and surface measurement is to be provided to improve his practical ability to control the processes.

· **Solid State Physics (3)**

Basic principles of modern physics and quantum mechanis, such as wave equation, free electrons, crystal lattice and diffraction phenomenon, are presented on the nanometer scale. Applications to solid state and nano structured materials will be emphasized including band structure, bonding, and electronic response in crystal lattice.

- **Powder Processing (3)**

  Topics include fabrication, properties, components of powder and fundamentals of sintering. Industrial application examples of powder metallurgy are also examined.

- **Alloy Design (3)**

  The objective of this course is understanding of advanced principles and applications of heat treatment on alloys. Impacts of heat treatment on hardenability and correlations of microstructures and mechanical properties are examined. Design and analysis of alloy are practically discussed.

- **Ferrous Materials (3)**

  Fundamentals of alloy components and heat treatment effects on mechanical properties of carbon steels and alloys.

- **Non-Ferrous materials (3)**

  This course is designed for understanding of fundamental properties of nonferrous metals, such as Cu, Al, Pb, Ti, and noble metals. The mechanical properties of various alloys are discussed from the viewpoint of materials science.

- **Fracture Mechanics of Engineering materials (3)**

  Based on fracture mechanics, characterization and design applications of fracture, fatigue, creep of metals are studied.

- **Plastic Deformation in Metals (3)**

  Elastic and plastic behaviors of metals under applied force are discussed in this course. Principles and techniques of plastic working are also introduced. Effects of mechanical work on metal involving its microstructure change and its behaviors on the properties are also discussed.

- **Advanced Diffusion in Materials (3)**

  In this course, based on statistical mechanics, the atomic level theory is studied on the mass transport and energy and momentum balance to the solution of heat, diffusion and fluid flow problems relevant to materials processing and microstructure. How to describe diffusion in materials at the nano-scale will be discussed as well as the effect of various stress and defect states in the materials.

· **Advanced Metallic Materials (3)**

The manufacturing technologies and application of the recent developed metallic materials, such as shape memory alloys, light metallic materials and ultra fine grained materials are introduced.

· **Manufacturing Process of Metallic Materials (3)**

The application of the principles in metallurgy, such as transformation, deformation and the manufacturing technologies are introduced. Especially, the required principles in the application of deformation process such as rolling, wire drawing, forging is discussed.

· **Advanced Process Design of Metallic Materials (3)**

Recent advanced technology in processing and design of metallic materials is presented and studied along with their applications, such as processing of nano materials, multi phase materials, and shape memory alloys.

· **Manufacturing Process for Materials (3)**

Manufacturing processes to make desired shapes and their effects on the properties of materials are introduced and taught on the basis of the plastic deformation and the metallurgical fundamentals.

· **Purification of Materials (3)**

The concept of chemical potential and the relation of phase rule, phase diagram, and mass transfer are discussed. The topics includes the exercise on the solution thermodynamics, and experimental measurement of thermodynamic quantities, and example for purification of materials.

· **Advanced Computational Materials Science (3)**

This course introduces advanced computer modeling methods in materials science and engineering using discrete particle systems and continuum fields. It covers techniques and software for statistical sampling, simulation, and uses statistical, quantum chemical, molecular dynamics, Monte Carlo, mesoscale and continuum methods to study fundamental physical phenomena encountered in the fields of computational physics, chemistry, mechanics, materials science, biology, and applied mathematics. A term project allows development of individual interests. Students are mentored by members of CMS Lab. in KMU.

· **Surface and Interface Science (3)**

This course surveys the basic concepts of surface and interface free energy, various phase transitions on the surface and interface such as surface roughening, surface reconstruction, etc.. Goals of the course also include the understanding of reaction

rate on the surface and interface, physi or chemi sorption, the role of stress in thin film growth, etc..

· **Nanotechnology (3)**

This course will introduce students to the relevant concepts related to the synthesis, science, characterization, and engineering of nanomaterials. Special applications in nanotechnology will also be reviewed, including bio medical, environmental, energy, defense, and telecommunication areas.

· **Electrochemical Engineering (3)**

Electrochemical Engineering is the course to understand the electrochemical principles and how to apply those theories to the relevant industries such as corrosion, surface finishing, battery and fuel cell and hydrometallurgy. This course covers the fundamental concept of electrochemistry, the equilibrium and the kinetics of electrochemical reactions, the corrosion of materials, the surface treatment, and the energy conversion methods such as battery and fuel cell.

· **Electrochemistry (3)**

This course is designed to understand fundamentals of electrode reactions, thermodynamics of solutions, structures of charged interface, and reaction kinetics. The engineering applications of electrochemistry are emphasized.

· **Corrosion Engineering (3)**

This course is designed for an advanced treatment of corrosion and its control in metals and alloys, stressing fundamentals of electrochemistry and their applications to corrosion system, thermodynamics, and kinetics and their relationship to corrosion reactions. Topics include the Butler Volmer equation, the Wagner Traud analysis, the Pourbaix diagram and Evans diagram, treating electrode reactions, passivity, effects of metallurgical factors on corrosion, anodic and cathodic protection, protective coatings, inhibitors and the proper alloy selections of particular corrosive environments.

· **Mechanics of Materials (3)**

Mechanics of materials deals with the mechanical behaviors of materials when they are loaded. Topics include force and moment, the relationship between stresses and strains, mechanical matters on deformation, compression, torsion, bending, beam deflection, and buckling in a practical manner. This course may provide the fundamentals of elasticity and plasticity as well as the theoretical background of mechanical metallurgy and deformation processing.

· **Advanced Ceramic Materials (3)**

Definition and crystal structures of ceramic materials are fundamental topics and

different kinds of bonding and defect structures are advanced subject in this course. In addition it includes effect of crystal structures and defect structures on their physical properties.

· **Materials for Information Technology (3)**

This course will present to students information storage, transmission, and related materials and technology with special emphasis on materials technologies in the areas of optical information processing, memory semiconductors, and large scale information storage.

· **Electronic Display Engineering (3)**

The purpose of this course is to gain an understanding of the principles and techniques of materials and process for flat panel displays (EL, LCD, PDP, FED....) fabrication. Topics also include the characterization and evaluation of display materials and related technologies. Emphasis on materials design in relation to fundamental device characteristics.

· **Nano-material Chemistry & Technology (3)**

In this course, students will learn critical knowledge of chemistry and technology in the areas of advanced metals, polymers, and ceramics. Course modules will cover the fundamental scientific principles of molecular structure, chemical bonding, and structural measurement and analysis of materials at nano scale level as well as related basic theories and mechanisms.

· **Advanced Polymer Materials (3)**

Overview of the problems associated with the selection, design, and function of advanced polymers is presented in this course. Particular emphasis is placed on discussion of the advanced application areas of polymer materials, which may include display, semiconductor, and energy technologies.

· **Materials Recycling Engineering (3)**

Environmental problems are discussed in global scale. Recycling methods for the ferrous and nonferrous scrap and other resources are introduced with their problems. Recent trend in recycling of resources is discussed in related with environmental features.

· **Iron and Steel Processing (3)**

The course is designed for thermodynamic and kinetical treatment of reduction and oxidation reactions, Si Mn reactions, and sulfur reactions for iron and steel making. Topics also include special melt refining.

· **Solidification of Metals (3)**

Topics include properties of melts, solidification of pure metals and alloys, solidifi-cation in a mold, gas at the solidification.

· **Imperfection in Solids (3)**

In this course, fundamental structures of solids, such as arrangement of atoms, direction and plane of lattice are depicted. Topics discussed include point defects, line defects, surface and interactions between dislocation and point defect.

· **Thermodynamics of Phase Equilibria (3)**

The lecture includes the equation of Gibbs free energy, lattice stability, sublattice model of solution and compounds, and the exercise will be made for calculation of phase diagram. Some examples for alloy and semiconductor systems are discussed.

· **Diffraction in Material Science (3)**

In this course, basic principles of techniques used in the characterization of engineering materials by X-ray diffraction are discussed. In addition, fundamental crystallographic study on the engineering materials is also conducted and related to X-ray diffraction phenomena.

· **Crystallography (3)**

This course describes system and symmetry of crystalline and explains material properties made a use of tensor. Mathematical expression on material characteristics including electrical and magnetic as well as mechanical properties.

· **Composite Materials (3)**

In composite materials system of metals, ceramics, carbon fibers and glass fibers, bonding structure, mixing principles, interfacial structure, mechanical properties and causes of fracture are discussed. Design and fabrication of composite materials are studied.

· **Welding Metallurgy (3)**

This course is design to understand effects of heat transfer, phase transformation, grain growth, formation of defects and residual stress due to welding of metals. Topics include evaluation and development of welding process.

· **Electronic Materials Fabrication Processing (3)**

The goal of this course is to provide the student with a fundamental understanding of each process for the fabrication of microelectronic and electronic devices. The processes of oxidation, diffusion, iron implantation, etching, photoli-thography, metallization and packaging will be discussed with an emphasis on the principle of

each process and its equipment, and the process related issues.

· **Reaction Kinetics (3)**

Topics include measurement techniques of concentration and reaction rate in chemical reactions, single step and multi step reactions, order of reaction, solid catalyst reactions, gas solid noncatalyst reactions, solid liquid reactions.

· **Mechanical Properties of Thin Films (3)**

This course covers the mechanical properties of the thin films deposited on various substrates with an emphasis on thin film dynamics, process related stresses, and the measurement of thin film stresses. In addition, effects of the microstructure of thin film depending on the process variables such as substrate temperature and pressure, on its plastic deformation and elastic behavior will be discussed.

· **Heat Treatment Engineering (3)**

The effects of heat treatment on properties and microstructures of metallic materials and the rcent trend of new technologies are introduced. Based on the principals of phase transformation and strengthening in metallurgy, the relationship between mechanical properties and microstructures, newly introduced manufacturing process, and the application of heat treating technology to machine parts and structures are discussed.

· **Materials in Energy and Environmental Application (3)**

Energy Storage and Conversion Materials is the course to understand the electrochemical principles related with energy storage and conversion materials and how to apply those principles to the relevant industries such as primary and secondary batteries, fuel cell and hydrogen storage materials. This course covers the fundamental concepts of thermodynamics and the equilibrium and the kinetics of electrochemical reactions associated with energy conversion materials and methods.

· **Special Topics in Structural Materials (3)**

This course covers the special topics and recent case studies in the field of advanced structural materials. Design issues pertaining to materials selection for load bearing applications are also discussed. Specific topics include engineering materials, structure property relationships, materials selection for design, and mechanical behavior of advanced materials through recently published critical papers.

· **Special Topics in Electronic Materials (3)**

This course is an introduction to the physical principles underlying the electric properties of modern solids with emphasis on semiconductors.

· **Speical Topics in Electro-Chemistry (3)**

This course deals with the recent theory on electrochemistry and corrosion. Mechanisms and rates in relation to physiochemical and metallurgical factors are also discussed.

· **Special Topics in Computer Application in Materials (3)**

This course is an introduction to computational materials science. Development of atomic and molecular level simulations for materials science applications will be discussed. Additionally, simple numerical methods are presented for solving differential equations and for studying correlations.

· **Special Topics in Nano-Materials (3)**

In this course, the essential properties of nanomaterials and their relevant concepts governing the synthesis, science, and engineering of nanomaterials are discussed. In addition, new properties at the nanoscale and existing and emerging applications of nanomaterials are presented.

· **Advanced Physical Metallurgy (3)**

Advanced theories, novel techniques, and recent industrial applications related with physical metallurgy.

· **Advanced Chemical Metallurgy (3)**

Advanced theories, novel techniques, and recent industrial applications related with chemical metallurgy.

· **Advanced Theory in Property of Materials (3)**

In this course, a survey of Materials Science and the physical properties of materials at the beginning graduate level is presented. Focus should be on the nature of microstructure and its manipulation and control to determine engineering properties: reviews include bonding, structure and microstructure, the chemical, electromagnetic and mechanical properties of materials.

· **Advanced Process in Manufacturing Materials (3)**

The principles of materials processing with emphasis on the use of processing to establish microstructures with impart desirable engineering properties. Some of the topics in this course should include solidification, thermal and mechanical processing, powder processing, and surface treatments.

· **Seminar in Process Design Engineering (3)**

Principal of process design in advanced materials engineering, recent trend of special technology and problems in advanced materials processing are discussed.

· **Seminar in Materials Engineering (3)**

Principles of materials engineering, recent trend of special technology and problems in advanced materials engineering are discussed.

· **Research Ethics & Thesis Study (3)**

Engineering is the application of scientific/technological knowledge. in order to design, produce/build, and maintain structural and machines/devices systems and it has changed our lives significantly in various ways. This course helps students understand how engineering has changed the world and the students learn how to solve various engineering ethics problems synthetically.

· **Smart Fashion Convergence Research (3)**

Fashion items with functionalities based on module system are investigated in convergence of design, technology and marketing. Constructing platform for wearable electronics is critical issue and various disciplines should cooperate to build it. This course aims the convergence research to figure out the solutions for smart fashion and killer application.

· **Functional soft materials (3)**

Organic and polymeric materials form a variety of hierarchical self-assembled structures based on various intermolecular interactions between the molecules. By the study on the thin film formation, and long range ordering and miniaturization of structures in the material development on the basis of the self-assembly, it is possible to create the most suitable functions and physical properties of the materials in each device.

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