Materials Chemistry Syllabus

Course Information					
*Course Code	MSE2602-1	*Credit Hours	32	*Credits	2
*Course Name	Materials Chemistry				
Course Type	Required course				
Audience	Sophomore				
Language of Instruction	English				
*School	School of Materials Science and Engineering				
Prerequisite	College Chemistry; College Physics; Thermodynamics thermodynamics of material.				
Instructors	Huanan Duan, Chuanliang Feng		Course Webpage	https://oc.sjtu.edu.cn/courses/19017	
*Description	Materials chemistry is the study of the synthesis, structure, properties, and application of solid materials. Our technology-driven world is fuelled by advances in materials chemistry with examples of application in areas such as microelectronics, polymers, and energy technology. This course introduces the materials chemistry of several major categories of materials (metals, ceramics and glasses, semiconductors, polymers, nanomaterials) with the emphasis of materials synthesis. The topics span from traditional extractive metallurgy to more recent development of nanomaterials and biomaterials. Through the study of this course, students can master the basic knowledge and theory in the field of materials science and chemical preparation in the material industry, understand the industrial status of related fields, research frontiers, and the concepts of environmental protection and sustainable development that may be involved, and learn to analyze and solve problems by applying the basic knowledge and literature study. This course also lays a good foundation of knowledge in materials chemistry and thinking methods for the undergraduate study of materials discipline. The main contents of this course include the introduction of material chemistry, the theoretical basis of bonding theory and crystal field theory, basic metallurgy methods, the electrochemical methods, preparation methods for inorganic materials (including nanoparticles, thin films, ceramics etc.), synthesis and preparation of polymer materials; the chemistry of organic/inorganic hybrid materials.				

Course syllabus

	Chapter	Hours	Method	Assignment	Learning objectives	Quiz
*Class Schedule& Requirements	Chapter 1 Introduction to Maters Chemistry	2	Lecture	Homework (HW)	• To explain why different materials are different • To appraise the trend of materials development • To relate the Mater. Chem. to Mater. Sci. & Eng. and the outside world	
	Chapter 2 Metals (6)					
	Metals	2	Lecture	HW	• To sketch the concept of electronic band structure • To use the electronic band structure to explain some properties of metals	
	Extractive Metallurgy	2	Lecture	HW	• To weight pyrometallury and hydrometallurgy by comparing two cases: extraction of Fe and Cu • To list general steps of hydrometallurgy • To explain pyrometallury, hydrometallurgy, and leaching.	
	Electrometallurgy	2	Lecture		• to use the standard reduction potential table to explain phenomena • to select appropriate electrolyte for electrolysis • to assess different corrosion control techniques	Quiz
	Chapter 3 Ceramics and Glasses (8)					
	Overview and solid state reaction (SSR)	2	Lecture	HW	• To describe general steps involved in solid-state reactions • To explain diffusion and its mechanism	
	SSR	2	Lecture	HW	• To describe the driving forces for sintering • To name two types of sintering mechanisms and explain them	
	Solution chemistry	2	Lecture	HW	• To analyze the surface charge of a colloidal particle • To apply the EDL to analyze the stability of colloids	

Solution-based synthesis	2	Lecture		• To explain alkoxides, hydrolysis, and condensation • To analyze a sol-gel process • To explain the water property under hydrothermal conditions • To design an autoclave based on the solubility-temperature plots	Quiz
Chapter 4 Semiconductors (6)					
Semiconductors and Si production	2	Lecture	HW	• To apply the band structure model to explain properties of semiconductor and working mechanisms of devices • To sketch the electronic band structure of doped semi and p-n junctions • To describe the CZ method and the float-zone method	
Lithography	2	Lecture	HW	• To describe photolithography: • Environment: clean room • Components: light source and photoresist • Step-by-step process of photolithography	
Thin film depositions	2	Lecture		• Be able to describe the basic mechanisms of the additive processes: • Physical Vapor Deposition (evaporation, sputtering) • Chemical Vapor Deposition	Quiz
Chapter 5 Polymers (10)					
Polymer overview	2	Lecture	HW	• Basic concepts of polymers • Classification and naming of polymer compounds • Classification of polymerization reactions • Average molecular weight of polymer and its distribution • Polymer physical state and transformation	
Free radical polymerization	2	Lecture	HW	• Free radical polymerization mechanism • Chain-initiated reaction • Free radical polymerization kinetics • Average polymerization degree of polymer • Factors affecting free radical polymerization • Inhibition and retardation	

	Ionic polymerization	2	Lecture	HW	• Cationic polymerization • Anionic polymerization • The difference between ionic polymerization and free radical polymerization • • Coordination polymerization	
	Stepwise polymerization	2	Lecture	HW	• Gradual addition polymerization • The molecular weight distribution • Stepwise polymerization method	
	Organic/ inorganic hybrid materials chemistry	2	Lecture	HW	• Concept of organic / inorganic hybrid materials • Self-assembled organic / inorganic hybrid nanomaterials • Hybridization of organic components on inorganic surfaces • Bionic organic / inorganic hybrid materials	
	Summary					
*Assessment	HW 15% + Quiz 15% + Class participation 10% + midterm 10% + Final exam 50%					
* Textbooks	There is no required textbook. Below are a few reference books: 1) Introduction to Materials Chemistry, Harry R. Allcock, Wiley 2008. 2) Materials Chemistry by B. Fahlman, Springer, 2011 (Available as a free ebook through the SJTU library website). 3) Ceramic Processing and Sintering by Rahaman, CRC Press, 2003. 4) Chemistry – the Central Science by Theodore L. Brown, H. Eugene LeMay, Jr., Bruce E. Bursten, Catherine J. Murphy, and Patrick Woodward, Pearson Education, Inc., 2009					