

课程大纲

COURSE SYLLABUS

1.	课程代码/名称 Course Code/Title	电极过程动力学导论 Introduction to Kinetics of Electrode Processes
2.	课程性质 Compulsory/Elective	专业选修课 Major Elective Courses
3.	课程学分/学时 Course Credit/Hours	2/32
4.	授课语言 Teaching Language	英文 English
5.	授课教师 Instructor(s)	顾均 助理教授 30015662
6.	是否面向本科生开放 Open to undergraduates or not	是
7.	先修要求 Pre-requisites	本科生选课需先修《物理化学 I》 CH301 Physical Chemistry I: CH301
8.	教学目标 Course Objectives	
	<p>本课程是针对化学、材料化学专业研究生以及化学专业高年级本科生开设的专业选修课。旨在帮助学生构建电化学的基本理论基础，理解电极过程的物理化学原理，掌握电化学测试分析的基本方法，了解电化学在能源存储利用、污染物降解等前沿领域中的应用，为将来在相关领域的研究打好基础。</p> <p>This is an elective course designed for graduate students major in chemistry and material chemistry and senior undergraduate students major in chemistry. The objectives are to help students to build up the knowledge frame of the theory in electrochemistry, understand the physical and chemical principles of electrode processes, grasp the basic experimental methods for electrochemical measurement and analysis, learn the latest progresses in the applications of electrochemistry in the fields of energy storage and conversion and degradation of pollutant substances, gain a good basis for the future research in the related fields.</p>	
9.	教学方法 Teaching Methods	
	课堂讲授 Classroom teaching	
10.	教学内容 Course Contents	
	Section 1	<p>A brief introduction to electrode processes 电极过程在能源存储、合成化学和分析化学中的应用； 介绍超级电容器、电池、燃料电池和电解池的概念； 法拉第过程与双电层充电过程； 法拉第电流与电极反应速率的关系。</p> <p>The application of electrode processes in energy storage, synthetic chemistry and analytical chemistry. The concept of supercapacitors, batteries, fuel cells and electrolysis cells. Faradaic process and charging of electric double layer. Relationship between Faradaic current and the rate of electrode reaction.</p>
	Section 2	<p>Thermodynamics and electrode potential 电势与反应能量的关系； 半反应与电极电势；</p>

	<p>Nernst 方程：电极电势与浓度的关系； 参比电极与三电极系统； 过电势。</p> <p>Relationship between potential and reaction energetics. Electrode reaction and electrode potential. Nernst equation: Relationship between concentration and electrode potential. Reference electrode and three-electrode system. Overpotential.</p>
Section 3	<p>Properties of electrode-solution interface 双电层模型理论； 零电荷电势。</p> <p>Theory development of electric double layer model. Potential of zero charge.</p>
Section 4	<p>Mass transport in solution near electrode 对流、扩散、电迁移； 稳态对流扩散； 旋转圆盘电极； Poisson-Nernst-Planck 模拟</p> <p>Convection, diffusion and migration. Steady state process formed by convection and diffusion. Rotating disk electrode. Poisson-Nernst-Planck simulation.</p>
Section 5	<p>Kinetics of electron transfer Butler-Volmer 模型； 交换电流密度； 电子转移的微观机理。</p> <p>Butler-Volmer model. Exchange current density. Microscopic mechanism of electron transfer between electrode and species in electrolyte.</p>
Section 6	<p>Multi-step reactions 决速步骤、前置可逆步骤与反应级数； 表观 Tafel 斜率。</p> <p>Rate determining step, reversible steps before rate determining step and reaction order. Apparent Tafel slope.</p>
Section 7	<p>Basic potential step methods 计时电流法； 电势阶跃法； 稳态的建立； 超微电极。</p> <p>Chronoamperometry. Potential step method. Establishment of steady state voltammetry. Ultramicroelectrodes.</p>
Section 8	<p>Potential sweep methods 循环伏安法；</p>

	双电层电容与溶液电阻的影响； 电极过程可逆性。 Cyclic voltammetry. Influence of double layer capacitance and resistance of electrolyte solution. Reversibility of electrode reactions.
Section 9	Electrochemical catalysis 氢气析出与氢气氧化反应； 氧气生成与氧气还原反应； CO ₂ 电化学还原； 多孔电极与气体扩散电极。 Hydrogen evolution reaction and hydrogen oxidation reaction. Oxygen evolution reaction and oxygen reduction reaction. CO ₂ reduction reaction. Porous electrode and gas diffusion electrode.
Section 10	An introduction to impedance methods 电解池的等效阻抗； 表面转化步骤和扩散步骤对阻抗的影响； Nyquist 图。 Equivalent impedance of electrolysis cells. The influences of reaction on electrode surface and diffusion on impedance. Nyquist plot.
11. 课程考核 Course Assessment	
	出勤 20%；平时作业 60%；课程项目（课堂汇报 10%，论文报告 10%） Attendance 20%, Assignments 60%, Project (Presentation 10%, Report 10%)
12. 教材及其它参考资料 Textbook and Supplementary Readings	
	1. Electrochemical Methods, Fundamentals and Applications, Second Edition, A. J. Bard, L. R. Faulkner, Wiley, 2001. 2. 电极过程动力学导论, 查全性 等, 科学出版社, 2002.