

课程详述

COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	课程名称 Course Title	金属有机化学 Organometallics			
2.	授课院系 Originating Department	化学系 Department of Chemistry			
3.	课程编号 Course Code	CH214			
4.	课程学分 Credit Value	3			
5.	课程类别 Course Type	专业基础课 Major Foundational Courses			
6.	授课学期 Semester	春季 Spring			
7.	授课语言 Teaching Language	英文 English			
8.	授课教师、所属学系、联系方式 (如属团队授课, 请列明其他授课教师) Instructor(s), Affiliation & Contact (For team teaching, please list all instructors)	何振宇, 副教授, 化学系 HO Chun-Yu, Associate Professor, Chemistry jasonhcy@sustech.edu.cn			
9.	实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact	待公布 To be announced			
10.	选课人数限额(可不填) Maximum Enrolment (Optional)				
11.	授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other (Please specify)
	学时数 Credit Hours	48			48

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	无机化学导论 (CH213)
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	本课程为化学专业基础课，化学专业必修课，材料相关专业选修课。 This course should be taken by everyone contemplating doing Chemistry in the following years. It should however also be suitable for students majoring in Materials.
14. 其它要求修读本课程的学系 Cross-listing Dept.	

教学大纲及教学日历 SYLLABUS

15. 教学目标 **Course Objectives**

Inorganic chemistry deals with the properties of all of the elements in the periodic table.

Our aim is to provide a comprehensive and contemporary introduction to the diverse and fascinating discipline of inorganic chemistry. A foundation of inorganic and organometallic chemistry principles and theory followed by descriptive chemistry of the elements will also be included.

无机化学涉及元素周期表中所有元素的性质。

我们的目标是提供更全面和现代的无机化学（金属有机化学）的学科介绍，这包括一些无机和金属有机化学原理和理论的基础。

16. 预达学习成果 **Learning Outcomes**

In this particular part of the Inorganic Chemistry Course, the students should have basic understanding of the Organometallic Transformations and Catalysis at the end of this course.

在无机化学课程的这个特定部分，学生应该对本课程结束时的有机金属转化和催化有基本的了解。

17. 课程内容及教学日历（如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）

Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)



The core course coordinator is Prof. Jason C.-Y. Ho.

The course content included but not limited to how the electron counts and complex structural features may affect the reaction pathways, and it will illustrate how the combinations may achieve the desired selectivity and reactivity.

Those will be distributed in the Fall semester throughout accordingly.

The course consists of 3 credits, which will focus on

A) Organometallic Chemistry (16 hrs),

- Introduction on Organometallic Chemistry (2 hrs: basic idea and the general)
- Electron counting (4 hrs, distributed equally: 18 electron rule, conformation, structures)

The 18-electron rule is a rule used primarily for predicting and rationalizing formulae for stable metal complexes, especially organometallic compounds. The rule is based on the fact that the valence shells of transition metals consist of nine valence orbitals (one s orbital, three p orbitals and five d orbitals), which collectively can accommodate 18 electrons as either bonding or nonbonding electron pairs. This means that, the combination of these nine atomic orbitals with ligand orbitals creates nine molecular orbitals that are either metal-ligand bonding or non-bonding.

Electron counting is a formalism used for classifying compounds and for explaining or predicting electronic structure and bonding. Many rules in chemistry rely on electron-counting

- Common organometallic complexes (10 hrs, distributed equally: H, C, pi, CO and Carbene)

Transition metal hydrides are chemical compounds containing a transition metal bonded to hydrogen. Most transition metals form hydride complexes and some are significant in various catalytic and synthetic reactions. The term "hydride" is used loosely: some so-called hydrides are acidic (e.g., $\text{H}_2\text{Fe}(\text{CO})_4$), whereas some others are hydridic, having H-like character (e.g., ZnH_2).

Transition metal alkene complex is a coordination compound containing one or more alkene ligands. Such compounds are intermediates in many catalytic reactions that convert alkenes to other organic products.

Metal carbonyls are coordination complexes of transition metals with carbon monoxide ligands. Metal carbonyls are useful in organic synthesis and as catalysts or catalyst precursors in homogeneous catalysis, such as hydroformylation and Reppe chemistry. In the Mond process, nickel carbonyl is used to produce pure nickel. In organometallic chemistry, metal carbonyls serve as precursors for the preparation of other organometallic complexes.

In organometallic species, metal complexes with the formulae LnMCRR' are often described as carbene complexes. Such species do not however react like free carbenes and are rarely generated from carbene precursors, except for the persistent carbenes. The transition metal carbene complexes can be classified according to their reactivity, with the first two classes being the most clearly defined:

- Fischer carbenes, in which the carbene is bonded to a metal that bears an electron-withdrawing group (usually a carbonyl). In such cases the carbenoid carbon is mildly electrophilic.
- Schrock carbenes, in which the carbene is bonded to a metal that bears an electron-donating group. In such cases the carbenoid carbon is nucleophilic and resembles Wittig reagent (which are not considered carbene derivatives).

B) Reactions (16 hrs)

- Fundamental steps in Organometallic Chemistry (6 hrs, distributed equally: substitution, associative and dissociative mechanism)

Associative substitution describes a pathway by which compounds interchange ligands. The terminology is typically applied to coordination and organometallic complexes, but resembles the S_N2 mechanism in organic chemistry. The opposite pathway is dissociative substitution, being analogous to the S_N1 pathway. Intermediate pathways exist between the pure associative and pure dissociative pathways, these are called interchange mechanisms.

- Oxidative addition & reductive elimination (5 hrs, distributed equally)

Oxidative addition and reductive elimination are two important and related classes of reactions in organometallic chemistry. Oxidative addition is a process that increases both the oxidation state and coordination number of a metal centre. Oxidative addition is often a step in catalytic cycles, in conjunction with its reverse reaction, reductive elimination.

- Insertion and β -elimination (5 hrs, distributed equally)

β -Hydride elimination is a reaction in which an alkyl group bonded to a metal centre is converted into the corresponding metal-bonded hydride and an alkene. The alkyl must have hydrogens on the β -carbon. For instance butyl groups can undergo this reaction but methyl groups cannot. The metal complex must have an empty (or vacant) site cis to the alkyl group for this reaction to occur.

C) Catalysis (16 hrs).

- Applications and Catalysis (8 hrs, distributed equally: hydrogenation, dimerization, polymerization and Monsanto process)

Hydrogenation – to treat with hydrogen – is a chemical reaction between molecular hydrogen (H_2) and another compound or element, usually in the presence of a catalyst such as nickel, palladium or platinum. The process is commonly employed to reduce or saturate organic compounds. Hydrogenation typically constitutes the addition of pairs of hydrogen atoms to a molecule, often an alkene. Catalysts are required for the reaction to be usable.

Dimerization and Alkylation Processes, alkenes are dimerized for the production of gasoline and for comonomers such as 1-butene. These processes operate at several refineries across the world at the scales of about 400,000 tons/year (2006 report)

polymerization is a process of reacting monomer molecules together in a chemical reaction to form polymer chains or three-dimensional networks.

Monsanto process is an industrial method for the manufacture of acetic acid by catalytic carbonylation of methanol.

- Basic compound characterization methods, and Q&A. (8 hrs, distributed equally: NMR, IR, MS for Organometallic compounds)

核心课程协调人是 Jason C.-Y. Ho 教授。

课程包括 3 学分，重点将放在有机金属化学(16 小时)，反应(16 小时)和催化领域(16 小时)。

课程内容包括但不限于电子数量和复杂结构特征如何影响反应路径，它将说明这些组合如何达到所需的选择性和反应性。See the English version for details.

18. 教材及其它参考资料 Textbook and Supplementary Readings

1. L. M. Garey and A. T. Donald, Inorganic Chemistry, Fourth Edition Pearson Education (原版) [无机化学 第四版 (影印版), Higher education Press 高等教育出版社]
2. P. W. Atkins, T. L. Overton, J. P. Rourke, M. T. Weller, and F. A. Armstrong Inorganic Chemistry, Fifth Edition 2010, W. H. Freeman and Company New York
3. F. A. Cotton, G. Wilkinson, C. A. Murillo, M. Bochmann, Advanced Inorganic Chemistry, 6th Edition, Wiley-VCH, NY

课程评估 ASSESSMENT

19. 评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance		0		
课堂表现 Class Performance		0		
小测验 Quiz		0		
课程项目 Projects		0		
平时作业 Assignments		0		
期中考试 Mid-Term Test		0		
期末考试 Final Exam	2 hrs	60		
期末报告 Final Presentation		0		
其它 (可根据需要 改写以上评估方 式) Others (The above may be modified as necessary)		40		PBL and related items

20. 记分方式 GRADING SYSTEM

- A. 十三级等级制 Letter Grading
 B. 二级记分制 (通过/不通过) Pass/Fail Grading

课程审批 REVIEW AND APPROVAL

21. 本课程设置已经过以下责任人/委员会审议通过
 This Course has been approved by the following person or committee of authority

化学系教学指导委员会
 Teaching committee of the chemistry department