



**Chemistry 714 – Organometallic Chemistry of the Transition Elements (2-3 credits)
Fall 2019**

Canvas Course URL: <https://canvas.wisc.edu/courses/154024>

Meeting Time and Location: Tu/Th 9:30 – 10:45 am, Room 8335, Chemistry

Instructional Mode + Credit Hour Accounting

Instruction in this course will primarily occur in a lecture format, although some periods will be devoted to other modes. The three credit hours derive from the traditional Carnegie Foundation definition – we meet for lecture for the equivalent of 150 min per week (currently, two 75-min periods of faculty-student instruction). The credit standard for this course is met by an expectation of a total of 135 hours of student engagement with the course learning activities (at least 45 hours per credit), which include class attendance, reading, problem sets, and other student work as described in the syllabus.

INSTRUCTOR

Prof. Shannon S. Stahl

Office Hours: By appointment, please contact via email.

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OFFICIAL COURSE DESCRIPTION

Course Description

This course covers the fundamentals of organometallic chemistry, a branch of inorganic chemistry devoted to compounds with metal-carbon bonds that has had a broad impact in synthetic chemistry (both organic and inorganic). Starting from basic principles of bonding, ligand types, and fundamental reactions, the course will culminate with discussion of the mechanisms of complex transition-metal-catalyzed reactions that involve organometallic intermediates. It will not completely cover all of organometallic chemistry, which is much broader and deeper than a single semester of study. As a graduate level-course, there is a high expectation of independent learning and motivation by the student.

Catalog Requisites

Graduate student standing or CHEM 511

LEARNING OUTCOMES

1. Apply knowledge of periodic trends, molecular orbital theory, and molecular symmetry to describe the bonding interactions between transition metals and ligands.
2. Identify ligand classes in organometallic chemistry to determine metal oxidation state, d-electron count, and the total valence electron count for organometallic complexes.
3. Describe the mechanisms for fundamental reactions in organometallic chemistry, and be able to propose experiments, including kinetic, thermodynamic, or spectroscopic, to distinguish between possible mechanisms for any given organometallic reaction.
4. Combine fundamental reaction steps together to describe the overall mechanisms of common organometallic reactions and homogeneous catalyzed processes.
5. Demonstrate growth as reflective, self-directed learners through assessing your work, identifying misconceptions, and critically evaluating information from a variety of sources.
6. Articulate the rationale behind experimental results and answers to conceptual problems in verbal communications and written assessments using scientifically appropriate language.

GRADING

Homework	70% of grade
Quizzes	20% of grade
Presentation	10% of grade

Grading Errors: Any graded assignment may be submitted for regrading if you believe an error has been made. The request must be made within two school days of the date the work is returned. Do not mark on the graded exam or problem set if you plan to submit for regrading.

Grading Scale:

This course is graded as a graduate course. Graduate students are expected to maintain a GPA of at least 3.0 for satisfactory standing in the program. Your final grade for the course will be determined using the following scale, with the meaning of each grade paraphrased below. Although statistical tools will be used to assist in setting the grading scale, a simple curve will not be enforced. It is possible for everyone in the class to receive an A grade.

A	Excellent performance shown consistently in all aspects of the course
AB	Good performance with high achievement in most of the course
B	Adequate performance reflecting a basic understanding of the material
BC	Adequate performance with some deficiencies
C	Minimal performance with serious deficiencies
D	Unsatisfactory performance
F	Very unsatisfactory performance

EXAMS, QUIZZES, PAPERS & OTHER MAJOR WORK

Homework the majority of the grade will be derived from 7-8 problem sets, which are to be turned in at the beginning of class on the dates that they are due. Working in groups is allowed and encouraged, but everyone should provide their own answers. Additionally, answer keys or students' answers from previous years should not be consulted.

Quizzes Throughout the semester, 20-30 minute in-class quizzes will be given to assess your understanding of the course material. Quizzes are not comprehensive.

Presentation Once this semester, you will be required to give a short (10 minute, 3 slide) presentation on a recent, high-impact publication in organometallic chemistry.

TEXTBOOK, SOFTWARE, & OTHER COURSE MATERIALS

Recommended Textbook (a useful reference; not required):

Organotransition Metal Chemistry: From Bonding to Catalysis (978-1891389535)

John F. Hartwig

University Science Books: 2009

TENTATIVE SCHEDULE OF TOPICS

• **Fundamentals of Organometallic Chemistry**

Periodic trends across the transition series

Molecular orbital theory

Electron counting and oxidation state assignments

Electronic structure and molecular geometry

• **Ligands and Organometallic Chemistry**

Ligand classes in organometallic chemistry: L-type vs. X-type ligands

Hard-soft acid-base theory

Common ancillary ligands: phosphines, nitrogen ligands, *N*-heterocyclic carbenes

Multiply bonded ligands: carbenes, carbynes (and nitrenes/imidos, oxene/oxo)

Sigma adducts

• **Fundamental Reactions in Organometallic Chemistry**

Ligand association, dissociation and substitution

Oxidative addition / reductive elimination

Sigma-bond metathesis

Four-centered or [2+2] reactions

Migratory insertion / elimination

Nucleophilic addition to coordinated ligands

Transmetalation

• **Organometallic Chemistry and Homogeneous Catalysis**

Alkene isomerization

Hydrogenation

Hydroformylation and other carbonylation reactions

Hydrocyanation, hydrosilylation, hydroboration

Alkene polymerization (Ziegler-Natta)

Alkene/alkyne metathesis

Carbenoid-mediated reactions

C–H activation and functionalization

Cross-coupling reactions

ACADEMIC INTEGRITY

By virtue of enrollment, each student agrees to uphold the high academic standards of the University of Wisconsin-Madison; academic misconduct is behavior that negatively impacts the integrity of the institution. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these previously listed acts are examples of misconduct which may result in disciplinary action. Examples of disciplinary action include, but is not limited to, failure on the assignment/course, written reprimand, disciplinary probation, suspension, or expulsion.
<https://conduct.students.wisc.edu/syllabus-statement/>

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA.
<https://mcburney.wisc.edu/instructor/>

DIVERSITY & INCLUSION

Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals.

The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world. <https://diversity.wisc.edu/>