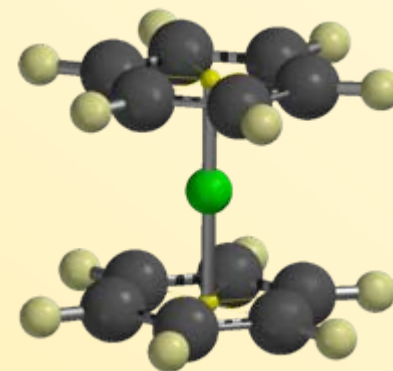
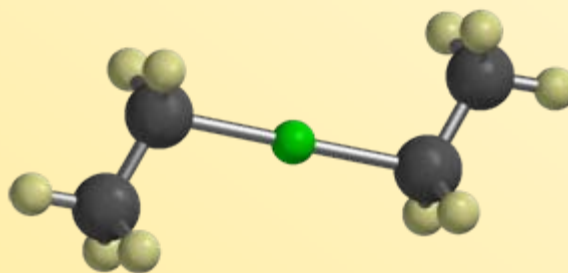
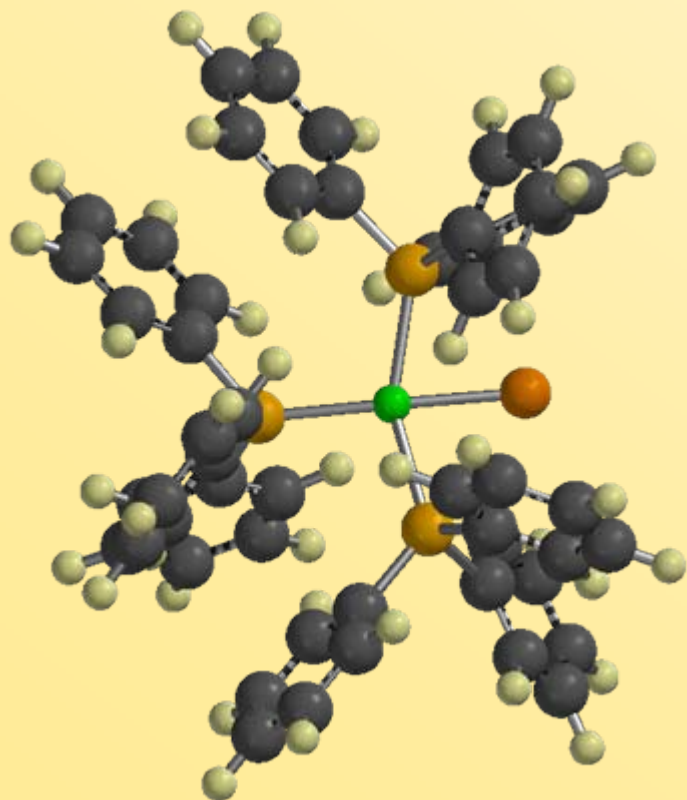


Organometallic Chemistry

between organic and inorganic



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Course Roadmap

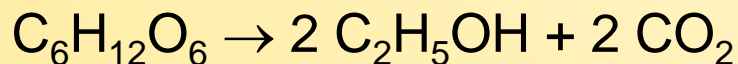
- A real example: the Monsanto Acetic Acid process
- Introduction: what is organometallic chemistry, and why should you care?
- Electron counting: the basis for understanding structure and reactivity
- An overview of Main-group and Transition metal chemistry
- Main group metal chemistry and "Umpolung"
- Intermezzo: characterization of organometallic compounds
- Transition metal chemistry: overview of common ligands
- Ligand substitution
- Insertion and elimination
- Oxidative insertion and reductive elimination
- More exotic steps
- ***Your own presentations***
- Applications in catalysis



Example: Acetic Acid synthesis

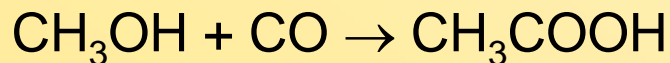
Acetic acid is an important industrial chemical.

The traditional synthesis uses bio-oxidation of ethanol obtained via fermentation:



This is **not** a clean and efficient process!

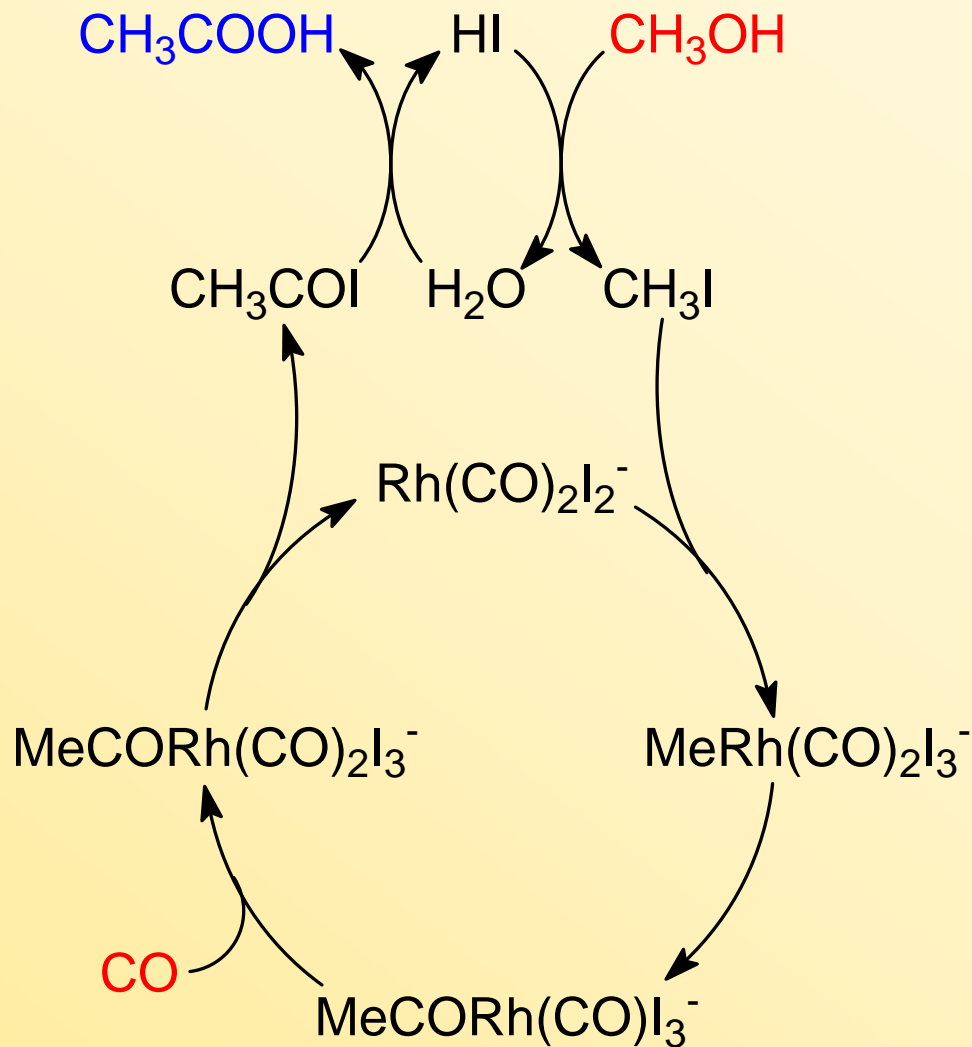
Industrial acetic acid synthesis:



Catalyzed by a rhodium complex.

Acetic Acid synthesis

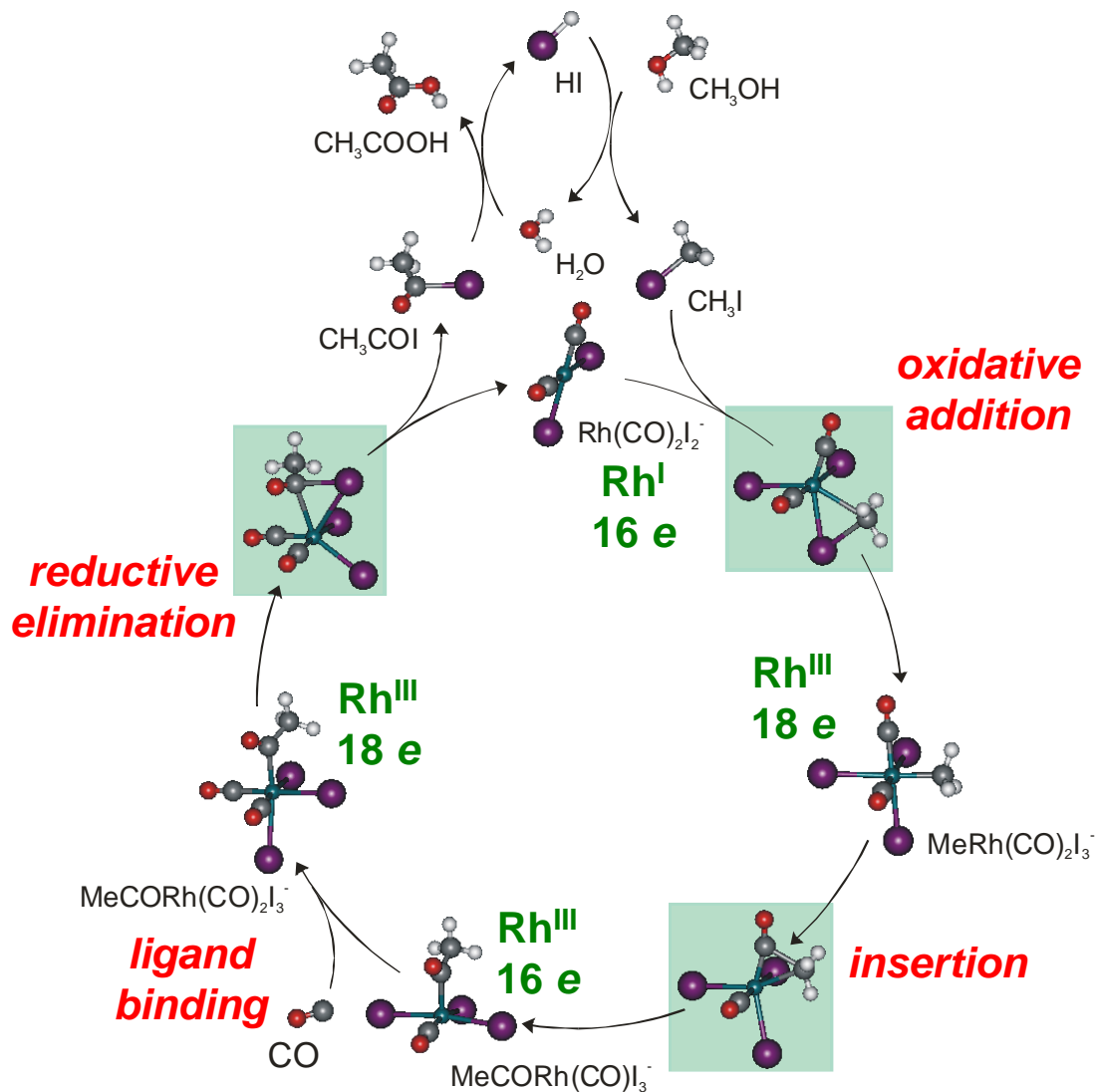
Moderately complex
catalytic cycle:



Acetic Acid synthesis

This cycle is known
in considerable detail:

To understand it,
you need to be familiar
with electron counting
and common
reaction types

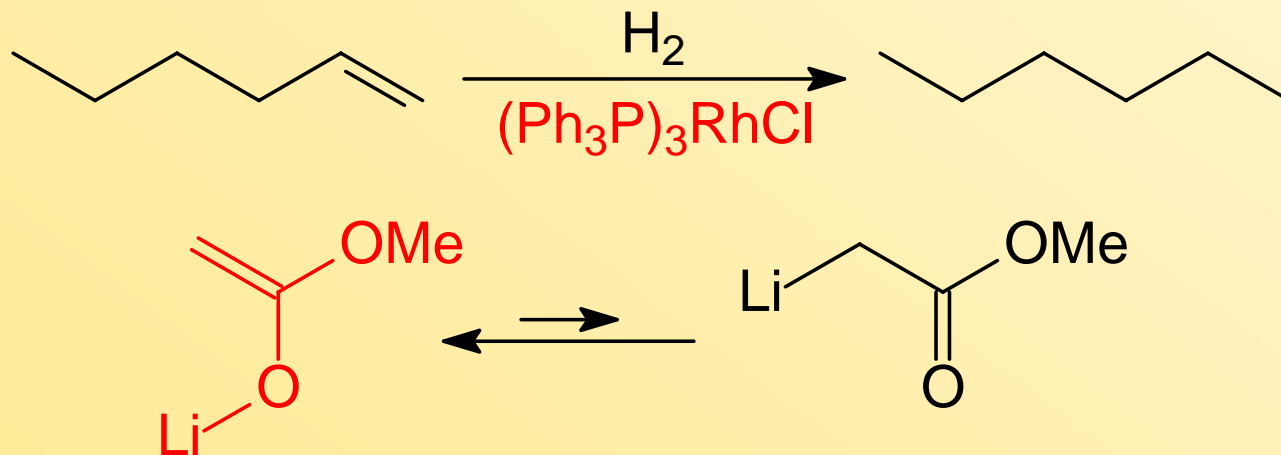


What is organometallic chemistry ?

Strictly speaking, the chemistry of compounds containing **at least one metal-carbon bond**.

Metal hydrides are often included, H being considered as the "smallest organic group" (as in propyl, ethyl, methyl, hydride).

Metal-carbon bonds are often formed **temporarily** or **potentially**, so in practice many compounds are included that do not actually contain metal-carbon bonds.



Why should you care ?

Organometallic chemistry is the basis of **homogeneous catalysis**, which is the method of choice for clean and efficient synthesis of fine chemicals, pharmaceuticals and many larger-scale chemicals.

Many **plastics** (polythene, polypropene, butadiene rubber, ...) and **detergents** are made via organometallic catalysis.

Organometallic chemistry is also the basis for understanding important steps in **heterogeneous catalysis** reactions such as olefin hydrogenation and CO oxidation.

Organometallic compounds are used on a large scale as precursors for **generation of semiconductors** (AlN, GaAs, etc).

Silicone rubbers are one of the few classes of organometallic compounds used as "final products".



Course Objectives

By the end of this course, you should be able to:

- Make an educated guess about stability and reactivity of a given compound, based on (a.o.) electron counting rules
- Propose reasonable mechanisms, based on "standard" organometallic reaction steps, for many metal-catalyzed reactions
- Use steric and electronic arguments to predict how changes in reactants, metal or ligands affect the outcome of reactions
- Read a current research literature paper, understand and explain its content and significance



Useful Background Knowledge

Organometallic chemistry (CHEM 4680) is a 4th-year course because it builds on:

- Organic chemistry: reaction mechanisms, primarily nucleophilic and electrophilic attack
- Inorganic Chemistry: electronegativity; electron counting and stability; properties of (transition) metals
- Physical chemistry: orbitals and MO theory; free energy, enthalpy and entropy

You will (now and then) *need* this background to understand the material or make assignments etc

