

# PG-SEM-IV Unit-III EC-1a Inorganic Chemistry Special

## Homogeneous catalysis

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### 8. Comparative analysis of catalytic systems

Reaction Type	Catalyst	Conditions	Selectivity
Hydrogenation	$\text{RhCl}(\text{PPh}_3)_3$	Mild, 1-10 atm	Chemoselective
Hydroformylation	$\text{HRh}(\text{CO})(\text{PPh}_3)_3$	80-120°C, 10-30 atm	High n/iso
Ziegler-Natta	$\text{TiCl}_4/\text{AlR}_3$	50-100°C, 1-10 atm	Stereospecific
Wacker Oxidation	$\text{PdCl}_2/\text{CuCl}_2$	100-120°C, 10 atm	Terminal alkenes
C-H Activation	$\text{Pd}(\text{OAc})_2$	80-150°C, $\text{O}_2$	Directed

### 9. Recent advances and future directions

#### Green Chemistry Aspects

- Aqueous Phase Catalysis:**
  - Water as solvent
  - Easier separation
- Biphasic Systems:**
  - Catalyst in one phase, products in another
  - Example: Ruhrchemie/Rhône-Poulenc process
- Supported Homogeneous Catalysts:**
  - Heterogenization on polymers, silica
  - Combines advantages of both

#### Asymmetric Catalysis

- Chiral Ligand Design:**
  - BINAP, DuPhos, Josiphos
  - High enantioselectivity (>99% ee)
- Applications:**
  - Pharmaceutical intermediates

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- Agrochemicals

### Photoredox Catalysis

- Using light to initiate catalytic cycles
- Mild conditions
- New bond formations

### Machine Learning in Catalyst Design

- Predicting catalyst performance
- High-throughput screening
- Rational design of ligands

## 10. Safety and environmental considerations

### Toxicology

1. **Metal Complexes:**
  - Heavy metal toxicity (Pd, Pt, Rh)
  - Proper handling and disposal
2. **Ligands:**
  - Phosphines: Pyrophoric, toxic
  - CO: Highly toxic

### Waste Management

1. **Catalyst Recovery:**
  - Distillation
  - Extraction
  - Membrane separation
2. **Metal Recycling:**
  - Economic necessity (Rh, Pt expensive)