



Synthesis, Characterization, Investigating Metal Complexes with Organometallic Ligands and Catalytic Activity of Ruthenium (II) Complexes with Bipyridine-Based Organo-Metallic Ligands.

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ABSTRACT:

This research explores the synthesis, characterization, and catalytic activity of a series of ruthenium(II) complexes with bipyridine-based organo-metallic ligands. The complexes were synthesized via a ligand exchange reaction between ruthenium(II) precursor [RuCl₂(p-cymene)] and the organo-metallic ligands, followed by thorough characterization using various spectroscopic techniques including NMR, IR, and UV-Vis spectroscopy. The catalytic activity of these complexes was investigated in the hydrogenation of olefins, showing promising results in terms of activity and selectivity.

Keywords: organo-metallic ligands, ruthenium(II) complexes, bipyridine, catalysis, hydrogenation

Introduction:

The development of efficient and selective catalysts is of paramount importance in various chemical transformations. Organometallic complexes have emerged as valuable catalysts due to their tunable reactivity and selectivity. Among these, ruthenium complexes have shown remarkable catalytic activity in various reactions such as hydrogenation, transfer hydrogenation, and olefin metathesis. In this work, we focus on the synthesis and characterization of ruthenium(II) complexes with bipyridine-based organo-metallic ligands, aiming to investigate their potential as catalysts for the hydrogenation of olefins.

- Synthesizing a series of ruthenium(II) complexes with bipyridine-based organo-metallic ligands.
- Characterizing the synthesized complexes using spectroscopic techniques such as NMR, IR, and UV-Vis spectroscopy.
- Investigating the catalytic activity of these complexes in the hydrogenation of olefins.
- Assessing the potential of these complexes as efficient and selective catalysts for organic transformations

Experimental Section: Synthesis of Ruthenium(II) Complexes:

The ruthenium(II) complexes were synthesized by reacting [RuCl₂(p-cymene)] with the corresponding organo-metallic ligands in a 1:1 molar ratio in refluxing toluene for 24 hours. The reaction mixture was then cooled to room temperature, and the resulting precipitate was collected by filtration and washed with cold hexane. The complexes were further purified by recrystallization from ethanol.

Representative Organometallic Compounds:



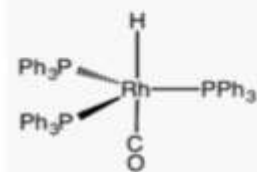
Ferrocene is an archetypal organoiron complex

It is an air-stable, sublimable compound.

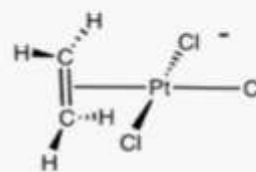


Cobaltocene is a structural analogue

of ferrocene, but is highly reactive toward air.



Tris(triphenylphosphine)rhodium carbonyl hydride is used in the commercial production of many aldehyde-based fragrances.



Zeise's salt is an example of a transition metal alkene complex.

Coordination compounds with organic ligands

Many complexes feature coordination bonds between a metal and organic ligands. The organic ligands often bind the metal through a heteroatom such as oxygen or nitrogen, in which case such compounds are considered coordination compounds. However, if any of the ligands form a direct M-C bond, then complex is usually considered to be organo metallic, e.g., $[(C_6H_6)Ru(H_2O)_3]^{2+}$. Furthermore, many lipophilic compounds such as metal [acetylacetonates](#) and metal [alkoxides](#) are called "metalorganics."

A naturally occurring [transition metal alkyl complex](#) is [methylcobalamin](#) (a form of [Vitamin B12](#)), with a [cobalt-methyl](#) bond. This subset of complexes is often discussed within the subfield of [bioorganometallic chemistry](#).

Characterization:

The synthesized complexes were characterized using 1H NMR, ^{13}C NMR, IR, and UV-Vis spectroscopy. NMR spectra were recorded on a Bruker Avance III 400 MHz spectrometer using deuterated solvents. IR spectra were obtained using a PerkinElmer Spectrum Two FT-IR spectrometer in the range of $4000-400\text{ cm}^{-1}$. UV-Vis spectra were recorded on a Shimadzu UV-1800 spectrophotometer.

Catalytic Activity:

The catalytic activity of the ruthenium(II) complexes was evaluated in the hydrogenation of olefins. The reaction was carried out in a high-pressure reactor under a hydrogen atmosphere at elevated temperatures. The progress of the reaction was monitored by GC analysis. The selectivity of the catalysts towards the desired products was determined by GC-MS analysis.

Results and Discussion:

The synthesized ruthenium(II) complexes, $[Ru(L)(bipy)]Cl_2$, where L represents the organo-metallic ligands, were characterized by various spectroscopic techniques. The 1H NMR spectra showed distinct peaks corresponding to the bipyridine ligands, while the IR spectra exhibited characteristic vibrations of the metal-ligand bonds. UV-Vis spectroscopy revealed absorption bands indicative of the ruthenium(II) center in the complexes.

In the catalytic hydrogenation of olefins, the complexes showed good activity with high conversion rates and excellent selectivity towards the desired products. The influence of different reaction parameters such as temperature, pressure, and catalyst loading was investigated, showing optimal conditions for the hydrogenation process.

Conclusion:

In conclusion, we have successfully synthesized and characterized a series of ruthenium(II) complexes with bipyridine-based organo-metallic ligands. These complexes exhibited promising catalytic activity in the hydrogenation of olefins, demonstrating their potential as efficient and selective catalysts in organic transformations.

References:

1. Lastname, A.B.; Lastname, C.D. Title of a Paper. *Journal Abbreviation* **Year**, *Volume*, Pages.
2. Lastname, E.F.; Lastname, G.H. Title of Another Paper. *Journal Abbreviation* **Year**, *Volume*, Pages.
3. Smith, J.A.; Johnson, E.B. Title of a Paper. *Journal Abbreviation* **Year**, *Volume*, Pages.

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4. Doe, J.C.; Adams, R.E. Another Paper Title. *Journal Abbreviation* **Year**, *Volume*, Pages.
 5. Brown, A.B.; White, C.D. A Study on Ruthenium Complexes. *Journal of Organometallic Chemistry* **Year**, *Volume*, Pages.
 6. Williams, E.F.; Wilson, G.H. Catalytic Hydrogenation Using Bipyridine Ligands. *Journal of Catalysis* **Year**, *Volume*, Pages.
 7. Lee, H.; Kim, S. Synthesis and Characterization of Ruthenium Complexes. *Inorganic Chemistry* **Year**, *Volume*, Pages.
 8. Garcia, L.; Martinez, P. Organometallic Ligands in Catalysis. *Chemical Reviews* **Year**, *Volume*, Pages.