

Synthesis, Spectroscopic Analysis and Catalytic Investigation of Ru(III) and Mn(II) Nitrogen-Based Complexes in Cross-Coupling Reaction

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Structured Abstract

Background: Ruthenium-based complexes and manganese-based complexes are emerging as promising alternatives to palladium-based catalytic systems due to their favourable properties and cost-effectiveness. The incorporation of nitrogen-based ligands contributes to the stabilization of these complexes while enhancing their catalytic efficiency. This study focuses on synthesizing and spectroscopic characterization of Ru(III) and Mn(II) nitrogen-based complexes to assess their potential for facilitating cross-coupling reactions in organic synthesis.

Methods: $\text{Cl}_3\text{H}_6\text{O}_3\text{Ru}$ and $\text{Mn}(\text{CH}_3\text{CO}_2)_2 \cdot \text{H}_2\text{O}$ were synthesized by reacting with Schiff base ligands and ethanol under ambient conditions. Characterization included Fourier Transform Infrared (FTIR), UV-Visible analysis, ^1H and ^{13}C Nuclear Magnetic Resonance (NMR), CHNs Analysis, molar conductivity and melting point. The percentage conversion of iodobenzene was measured using gas chromatography-flame ionization detection (GC-FID) to determine the catalytic activity of the produced metal complexes.

Results: RuBLH , RuBLOCH_3 , MnBLH and MnBLOCH_3 were obtained. FTIR spectra confirmed the presence of characteristic functional groups in the ligand and metal complex and also the coordination of nitrogen-based ligands through significant peaks at $1670\text{--}1550\text{ cm}^{-1}$ (C=N stretches) and $1270\text{--}1150\text{ cm}^{-1}$ (C–O bonds). UV-Vis spectroscopy of ruthenium complexes revealed absorbance at 430 nm, indicative of metal-ligand charge transfer. NMR spectra of Schiff base ligands provided detailed insights into the chemical environment of the complex. The percent conversion of iodobenzene for each metal complex was calculated for 3 hours, with RuBLH obtaining 43%. RuBLH was the most efficient catalyst.

Conclusion: RuBLH , RuBLOCH_3 , MnBLH and MnBLOCH_3 were successfully synthesized and characterized, confirming their structural and electronic properties. The catalytic properties of the synthesized Ru(III) and Mn(II) nitrogen-based complexes in cross-coupling reactions were completely investigated.

Keywords: Nitrogen-base ligand, ruthenium complex, manganese complex, catalytic activity, metal-ligand charge transfer

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