IR AND TG ANALYSIS OF COORDINATION COMPLEX BASED ON BENZIMIDAZOLE

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ABSTRACT

Coordination chemistry involving heterocyclic compounds has gained significant interest in the field of inorganic chemistry. Benzimidazole (BIM) derivatives are widely studied for their ability to form stable coordination complexes with various metal ions, due to the presence of nitrogen atoms in the heterocyclic ring. These complexes exhibit promising properties, including catalytic, antibacterial, and electrochemical activities. The main goal of this study is to synthesize a coordination complex based on benzimidazole and perform a comprehensive analysis using Infrared (IR), Differential Thermal Analysis (DTA), and Thermogravimetric Analysis (TG) to investigate the coordination behavior and stability of the complex. The obtained results provide valuable insights into the structure and stability of the metal-ligand interaction.

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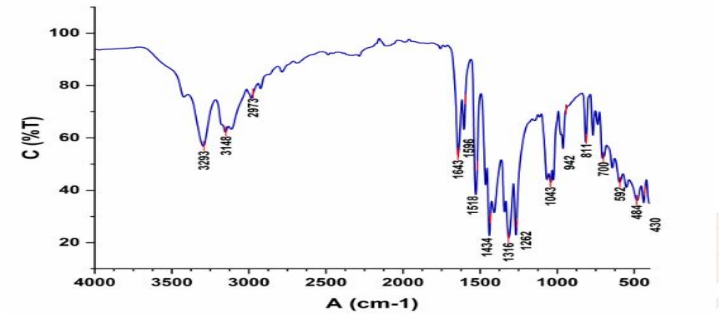
The coordination complex was synthesized by reacting benzimidazole (BIM) with a metal salt (e.g., $CuCl_2 \cdot 2H_2O$, $CoCl_2 \cdot 6H_2O$, $Ni(CH_3COO)_2 \cdot 4H_2O$, $Zn(CH_3COO)_2 \cdot 2H_2O$) in ethanol at slightly basic conditions (pH 7.5–8.0). The reaction proceeded as follows: A solution of benzimidazole (2 mmol) in ethanol was prepared; A solution of the metal salt (1 mmol) in ethanol was prepared separately; Both solutions were mixed, and the pH was adjusted to approximately 8.0 using sodium acetate buffer; The mixture was heated at 60 °C for 1–2 hours while stirring; The resulting solid complex was filtered, washed with ethanol, and dried at 50 °C. The yield of the complex was approximately 75–80%.

The synthesized coordination complex was characterized by IR spectroscopy, Differential Thermal Analysis (DTA), and Thermogravimetric Analysis (TG) to determine its structure and stability.

IR Spectroscopy. The IR spectrum of the complex showed the following characteristic peaks:

- ν(N–H)_stretch (3200–3400 cm^{-1}):A broad band, characteristic of the NH group in benzimidazole.
- ν(C=N)_ring (1590–1620 cm^{-1}): The stretching vibration of the C=N bond in the benzimidazole ring.
- ν(M–N) (450–550 cm^{-1}):The stretching vibration of the metal-nitrogen bond, indicating coordination between the metal ion and the nitrogen atom of the benzimidazole. - ν(M–Cl/S)



(200–400 cm^{-1}):The stretching vibration of the metal-chlorine or metal-sulfur bond in the complex.

Figure 1: IR results

DTA (Differential Thermal Analysis): The DTA curve showed an endothermic peak around 130 °C, which corresponds to the loss of solvent molecules (e.g., water or ethanol) from the complex. A sharp exothermic peak at 250 °C was observed, indicating the onset of decomposition of the complex. TG (Thermogravimetric Analysis): The TG curve showed a weight loss of approximately 10% below 150 °C, associated with the evaporation of solvent molecules. A more significant weight loss (~40%) was observed between 250–350 °C, indicating the thermal decomposition of the complex.

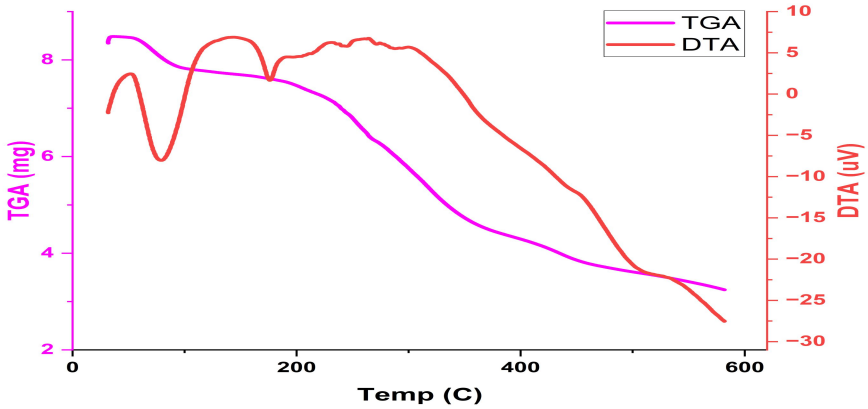


Figure 2: TG and DTA results

In conclusion, the coordination complex based on benzimidazole was successfully synthesized and characterized using IR, DTA, and TG analysis. The IR spectral data confirmed the coordination of the benzimidazole ligand to the metal ion through the nitrogen atom. The DTA and TG data provided valuable information on the thermal stability of the complex, indicating solvent loss at lower temperatures and decomposition at higher temperatures. These results demonstrate the potential of benzimidazole-based coordination complexes for various applications, including catalysis and material science.

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