

Preparation and Properties of Three Nickel(II) Complexes

by David Weatherburn

Experiment Overview

In this experiment three nickel(II) complexes with different geometries are synthesised. The magnetic moments of the complexes are measured in order to establish the correct geometry of each. Molecular mechanics calculations are used to rationalise the observed differences in geometry of two of the complexes.

Aims and Objectives

This experiment will develop skills in synthesis; introduce magnetic measurements as a means of investigating electronic and geometric structure; extend students understanding of the importance of both steric and electronic effects in determining molecular structure; and to demonstrate the use of computational chemistry in understanding steric influences.

Level of Experiment

Second year undergraduate, after exposure to lectures on coordination chemistry and crystal field theory. Students need to understand (or have explained) crystal field splitting and how this varies with different coordination geometries.

Keyword Descriptions of the Experiment

Domain

inorganic chemistry

Specific Descriptors

magnetic susceptibility, ligand field splitting d orbitals

Course Context

The course where this experiment is conducted is a stand alone synthetic chemistry course at the second year level. It combines inorganic and organic synthetic chemistry experiments. The organic part of the course is run first so that students when confronted with this experiment are relatively experienced in synthetic and separation techniques. Students who take this course do not necessarily have to have done, or be currently enrolled in, our second year inorganic course and indeed 40 % of the class taking the laboratory course are not. Most of these students are undertaking a Biotechnology degree which includes second year organic chemistry. We have found that with their knowledge from their first year course where crystal field splitting is first introduced and with an expanded set of notes outlining the theory in more detail these students are able to understand the principles just as well as the students who have done the Inorganic course.

Prerequisite Knowledge and Skills

Knowledge and skill requirements include:

- Nucleophilic substitution reactions in organic chemistry
- Basic knowledge of magnetic susceptibility
- Crystal field splitting of transition metal complexes and in particular the d^8 case
- Molecular mechanics

Time Required to Complete

Prior to Lab: 30 min

In Laboratory: > 6 h

After Laboratory: 2 h

Experiment History

This experiment has been run for a number of years in our second year synthetic chemistry laboratory. As far as the submitter's memory serves, it was discovered it in a laboratory manual from the University of Durham.

References

Stewart, J. M., Lingafelter, E. C., & Breazeale, J. D. (1961). The crystal structure of diaquabis(salicylaldehydato)nickel. *Acta Crystallographica*, **14**, 888-891.

Fox, M. R., Orioli, P. L., Lingafelter, E. C., & Sacconi, L. (1964). The crystal structure of bis-(*N*-isopropylsalicylaldiminato)nickel(II). *Acta Crystallographica*, **17**, 1159-1166.

Kamenar, B., Kaitner, B., Ferguson, G., & Waters, T. N. (1990). A redetermination of the structures of bis(salicylideneaminato)nickel(II) and monoclinic and orthorhombic forms of bis(*N*-methylsalicylideneaminato)nickel(II). *Acta Crystallographica Section C: Crystal Structure Communications*, **C46**, 1920-1923.