THERMAL DECOMPOSITION OF HEXAMMINE-
COBALT(III) CHLORIDE

Z. D. Zivkovic
Technical Faculty in Bor, 19219 Bor, Yugoslavia

(Received December 2, 1992, in revised form March 12, 1993)

Abstract

The results of comparative thermal analysis (TG-DTG-DTA-DSC) of the thermal decomposition of hexamminecobalt(III) chloride in air atmosphere are reported. The kinetics and mechanism of the thermal decomposition, the process enthalpy and the variation in specific thermal capacity of the solid product reaction with temperature were determined.

Keywords: complexes, hexamminecobalt(III) chloride, kinetics, TG-DTG-DTA-DSC

Introduction

The thermal decompositions of amminecobalt(III) complexes have been studied by several authors [1–6]. The published data relate to the thermal decompositions of [Co(NH3)6]Cl3, [Co(NH3)5Cl]Cl2 and [Co(NH3)6]2(C2O4)3·4H2O, but the results obtained are not complete.

As concerns the thermal decomposition of hexamminecobalt(III) chloride, recent studies [5, 6] have presented data obtained in air and argon atmospheres, but the data on the process mechanism are not compatible with data obtained in a previous investigation [1], and the differences have not been explained.

The present paper reports the results of comparative investigations of the thermal decomposition of hexamminecobalt(III) chloride by means of simultaneous DTA-TG-DTG analysis under nonisothermal conditions in air atmosphere. For determination of the enthalpies of the processes and the $C_p$ change of the solid product reaction, use was made of DSC measurements.
Experimental

The sample of hexamminecobalt(III) chloride was of p.a. purity; it was synthesized by Kemika, Zagreb. Thermal analysis was carried out on a derivatograph 1500, (MOM, Budapest, Hungary), and DSC analysis on a DSC-404 apparatus (NETZSCH). All analyses were performed in air atmosphere.

Results and discussion

Figure 1 illustrates results of simultaneous DTG-TG-DTG analysis of hexamminecobalt(III) chloride at a heating rate of 10 deg-min\(^{-1}\) in air atmosphere. From the mass loss results for certain processes (with an error less than 3\%), for the heating rate interval 2.5 to 20 deg-min\(^{-1}\), the following mechanism of thermal decomposition of \([\text{Co(NH}_3\text{)}_6\text{]}\text{Cl}_3\) was determined:

\[
\begin{align*}
6 \text{[Co(NH}_3\text{)}_6\text{]}\text{Cl}_3 & \rightarrow 3 \text{CoCl}_2 + 3 (\text{NH}_4\text{)}_2\text{CoCl}_4 + \text{N}_2 + 28 \text{NH}_3 & (1) \\
3 (\text{NH}_4\text{)}_2\text{CoCl}_4 & \rightarrow 6 \text{NH}_4\text{Cl} + 3 \text{CoCl}_2 & (2) \\
6 \text{CoCl}_2 + 4 \text{O}_2 & \rightarrow 2 \text{Co}_3\text{O}_4 + 6 \text{Cl}_2 & (3)
\end{align*}
\]

![Fig. 1 The results of simultaneous DTA-TG-DTG analysis for [Co(NH\text{)}\text{6}]\text{Cl}_3 in air atmosphere at heating rate of 10 deg-min\(^{-1}\)](image)

(1 - [Co(NH\text{)}\text{6}]\text{Cl}_3; 2 - Co\text{Cl}_2+(\text{NH}_4\text{)}\text{2CoCl}_4; 3 - Co\text{Cl}_2; 4 - Co_3\text{O}_4; 5 - CoO)

*J. Thermal Anal., 41, 1994*