Int. J. Chem. Sci.: 12(1), 2014, 1-4
ISSN 0972-768X
www.sadgurupublications.com

A NOVEL METHOD FOR SYNTHESIS OF Al_2O_3 USING UREA AT ELEVATED TEMPERATURE

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ABSTRACT

The Al_2O_3 was synthesized by a novel reactions of urea with $Al(NO_3)_3$ or $Al_2(SO_4)_3$, in an aqueous media at ~ 90°C. The infrared spectra and microanalysis, CHN, of the solid products indicated the absence of the bands of urea, but appearing the characteristic bands of oxide. A general mechanism describing the formation of oxides and decomposition of urea are suggested.

Key words: Al_2O_3, Infrared spectra, Aluminum salts, Urea.

INTRODUCTION

Urea and their derivatives are known to be the parent compound of a large and interesting class in both organic and inorganic compounds. It is used as a starting material for the synthesis of many applied compounds. The literature revels that urea is forming coordinate bonds with many metal ions at room temperature in aqueous and non aqueous media through its oxygen or nitrogen atoms depending on the type of metal ion used.[1-8] From the chemical viewpoint, the reaction of metal salts with urea at high temperature has recently gained increasing interest.[7-14] The nature of the reaction products depend strongly on the type of metal ions and so the metal salt used. In our previously studies[7-14] concerning the reaction of urea with metals such as Co(III), Pb(II), Sn(II), Cr(III), Fe(III), Au(III), Sn(IV), V(V) and Mo(IV) at high temperature demonstrate that the types of metal ions beside their anions have a pronounced effect on the nature of the reaction products. The published papers owned by us in this trend of the reaction of urea with different metal salts at elevated temperature lead to discovering a novel method for preparation $PbCO_3$ and $CoCO_3$[10], lanthanide carbonates[12], limonite, FeO(OH),[9] $2ZnCO_3.3Zn(OH)_2$,[8] and $SnOCl_2.2H_2O$.[7] The aim of this work is to report the synthesis and characterization study of the Al_2O_3 resulted from a novel oxidation reduction reaction between urea with $Al(NO_3)_3$ or $Al_2(SO_4)_3$ in an

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aqueous solution at ~ 90°C.

EXPERIMENTAL

All chemicals used throughout this study were Analar or extra pure grade. The white oxide, Al_2O_3 was prepared by mixing equal volumes of aqueous solutions of 0.1 M of $Al(NO_3)_3$ or $Al_2(SO_4)_3$ and 1.0 M of urea. The mixtures were heated on a water bath to approximately 90°C for about ~ 24 h. The white colored precipitate filtered off, washed several times with bi-distilled water and dried in *vacuo* over $CaCl_2$. The elemental analysis for the obtained products shows the absence of carbon, hydrogen and nitrogen elements. The percentage of aluminum was determined by using thermogravimetric method. The infrared spectra of the reactants and the solid products obtained were recorded from KBr discs using a Bruker FT-IR Spectrophotometer.

RESULTS AND DISCUSSION

The reaction of aqueous solutions of urea with $Al(NO_3)_3$ or $Al_2(SO_4)_3$, produces clear white colored oxide, Al_2O_3. The formation of this oxide upon the heating of an aqueous mixture of $Al(NO_3)_3$ or $Al_2(SO_4)_3$, respectively, with urea may be understood as follows:

$$2\,Al(NO_3)_3 + 20\,NH_2CONH_2 + 23\,H_2O \xrightarrow{90^oC} Al_2O_3\,(s) + 6\,HCl\,(g) + 20CO_2\,(g) + 40\,NH_3\,(g)$$

For the reaction mechanisms, an oxidation process for aluminium urea complex occurs during the decomposition of urea into ammonia, carbon dioxide and hydrogen chloride gases. The infrared spectra of synthetic oxide product are shown in Fig. 1.

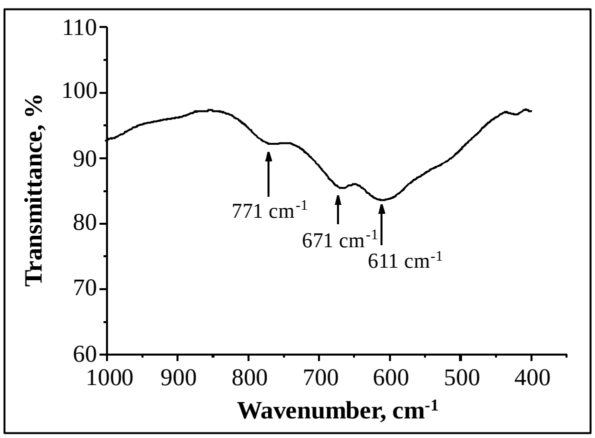

Fig. 1: Infrared spectrum of Al_2O_3 resulted from the reaction of urea with $Al(NO_3)_3$ or $Al_2(SO_4)_3$

The infrared spectra of the obtained products show no bands due to characteristic groups of urea (carbonyl and amide groups), but the bands associated to the oxides are observed[15]. Based on this observation along with the obtained data from elemental analysis, the infrared spectra of commercially obtained Al_2O_3 are the same as that of the reaction products.

CONCLUSION

This paper put a novel idea about a simple method for preparation of Al_2O_3 upon the reaction mechanism between urea and two aluminum (III) salts. The metal and anion have a major role in the decomposition of urea at low temperature rather than normal case.

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Revised : 08.11.2013 *Accepted : 10.11.2013*