SYNTHESIS AND INITIAL PHYSICO-CHEMICAL INVESTIGATIONS OF HETERONUCLEAR Cu(II)-Nd(III) COMPOUND

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ABSTRACT

The heteronuclear copper(II)-neodymium(III) compound having formula $[Nd(H_2O)_5(CuL)_2][CuL]\cdot 8H_2O$ was obtained by reacting Na[CuL] (where L = Schiff base) with $NdCl_3$. The complex was characterized by elemental analysis, thermogravimetric studies, ASA and magnetic measurements. Magnetic susceptibility measurements were carried out in the range of 76 – 303 K. The magnetic susceptibility data change with temperature according to the Curie-Weiss law with Θ = -35 K. The magnetic moment decreases from 5,00μ_B at 303 K to 4,38μ_B at 76 K.

INTRODUCTION

Heteronuclear compounds are the subject of the investigations for the reason of their particular physical and chemical properties. Besides they can be trated as models for investigation of magnetic exchange involving *d* and *f* electrons and because of their potential applications in production of high temperature superconductors and magnetic materials [1-7]. In this paper we have described synthesis and magnetic properties of $[Nd(H_2O)_5(CuL)_2][CuL]\cdot 8H_2O$.

EXPERIMENTAL

The violet crystals of $[Nd(H_2O)_5(CuL)_2][CuL]\cdot 8H_2O$ were prepared in the following way: glycylglycine (5mmol), 5-bromosalicylaldehyde (5 mmol) and NaOH (10 mmol) were dissolved and stirred in hot $EtOH/H_2O$ (v : v = 1 : 1). $CuCl_2\cdot 2H_2O$ (5mmol) was then added to the solution and the resulting solution was adjusted to pH ~ 9. Last excess of $NdCl_3$ (8 mmol) was added. The solution was filtred and the filtrate was allowed to evaporate slowly at room temperature.

The contents of carbon, hydrogen and nitrogen in the obtained compound were determined by elemental analysis using a CHN 2400 Perkin Elmer analyser. The contents of metals were established by ASA method using ASA 880 spectrophotometer (Varian).

Anal. Calcd. for $C_{33}H_{48}O_{24}N_6Br_3Cu_3Nd$: C, 26.6 %; H, 3.2 %; N, 5.7 %; Cu , 12.8 %; Nd, 9.7 %. Found: C, 27.8 %; H, 2.7 %; N, 5.5 %; Cu, 12.2 %; Nd, 10.3 %.

The dehydration process of Cu(II)–Nd(III) complex was studied in air using a Setsys 16/18 TG, DTA instrument. The experiment was carried out under air flow in the temperature range of 297–773 K. The sample (4.86 mg) of compound was heated in Al_2O_3 crucibles.

The magnetic susceptibility values of the Cu(II)-Nd(III) complex were determined by Gouy method in the temperature range of 76 – 303 K. The calibrant employed was $Hg[Co(SCN)_2]$ for which the magnetic susceptibility of $1.644 \cdot 10^{-5}$ cm^3g^{-1} was taken. Correction for diamagnetism of the constituent atoms was calculated by the use of Pascal′s constants [8]. The effective magnetic moment values were calculated from the equations:

$$\mu_{eff} = 2.83\ (\chi_M \cdot T)^{1/2} \qquad (1)$$

$$\mu_{eff} = 2.83\ [\chi_M (T - \Theta)]^{1/2} \qquad (2)$$

RESULTS AND DISCUSSION

The new heteronuclear copper(II)–neodymium(III) compound was synthesised and next on the basis of elemental analysis, thermal analysis, ASA and the literature of subject its formula $[Nd(H_2O)_5(CuL)_2][CuL]\cdot 8H_2O$ (where L = Schiff base derived from 5-bromosalicylaldehyde and glycylglycine) was established. The dehydration process of the obtained complex was studied in air atmosphere in the temperature range of 297–773 K. The Cu(II)–Nd(III) complex is stable up to 323 K. Next at 323 – 473 K it dehydrates in one step losing all molecules of lattice water. The mass loss calculated from TG curve being equal to 10.6% corresponds to the loss of 8 molecules of water (theoretical values is 9.7 %). The dehydration process is connected with an endothermic effect seen on DTA curve.

Experimental magnetic data plotted as magnetic susceptibility χ_g, $1/\chi_g$ and magnetic moment μ_{eff} versus temperature are presented in Table 1 and Figs. 1, 2 and 3.

Table 1. The magnetic data of $[Nd(H_2O)_5(CuL)_2][CuL]\cdot 8H_2O$

$[Nd(H_2O)_5(CuL)_2][CuL]\cdot 8H_2O$					
T (K)	$\chi_g \cdot 10^6$ (cm^3/g)	μ_{eff} (μ_B)	T (K)	$\chi_g \cdot 10^6$ (cm^3/g)	μ_{eff} (μ_B)
76	20.697	4.38	213	8.731	4.83
123	14.870	4.74	223	8.364	4.85
133	12.041	4.46	233	8.005	4.85
143	11.617	4.54	243	7.732	4.88
153	10.957	4.57	253	7.468	4.89
163	10.910	4.70	263	7.232	4.92
173	10.532	4.76	273	7.015	4.94
183	10.052	4.79	283	6.846	4.97
193	9.505	4.79	293	6.619	4.98
203	9.146	4.83	303	6.440	5.00

The magnetic susceptibility changes with temperature according to the Curie-Weiss law with $\Theta = -35$ K indicating the weak antiferromagnetic interaction in this complex (Table 1, Figs. 1, 2).

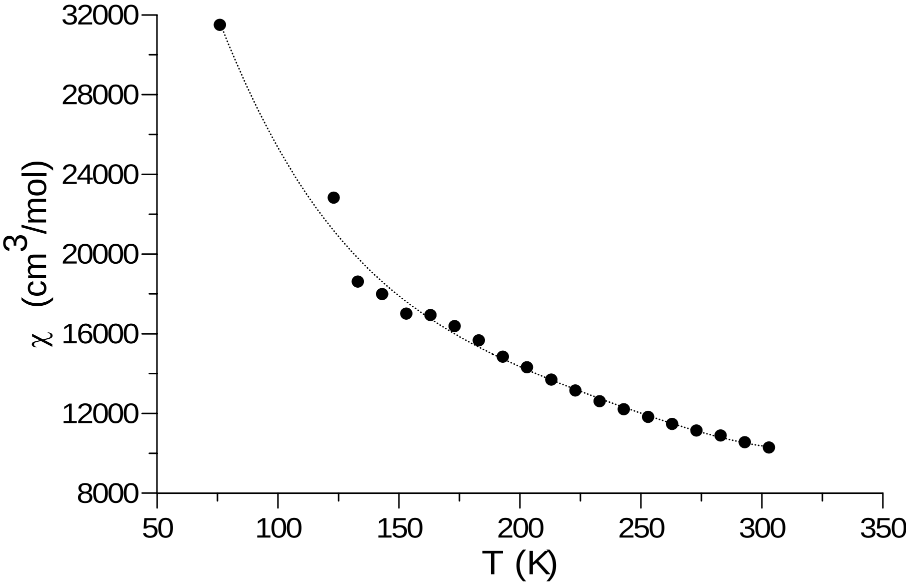

Fig. 1. Experimental magnetic data plotted as magnetic susceptibility χ_g *versus* temperature

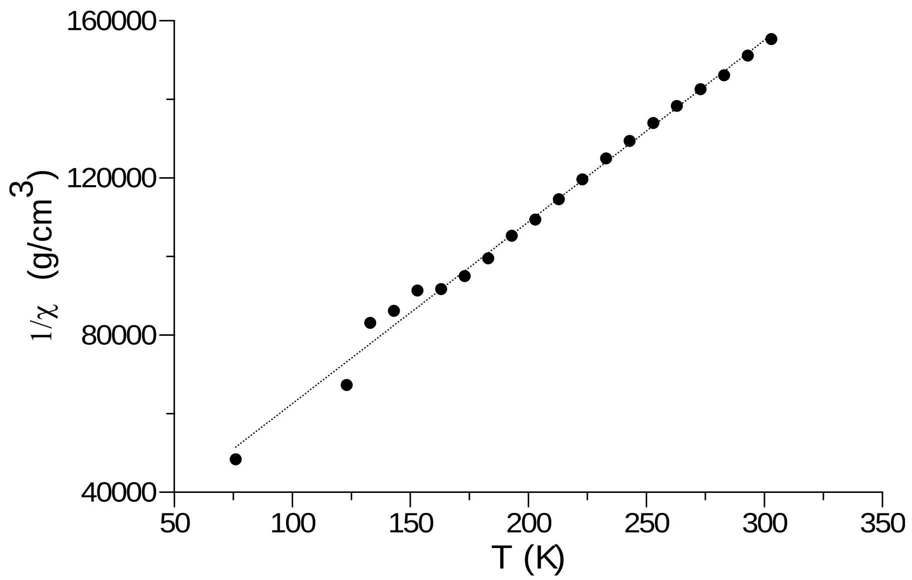

Fig. 2. Experimental magnetic data plotted as $1/\chi_g$ *versus* temperature

The magnetic moment values decrease from $5{,}00\mu_B$ at 303 K to $4{,}38\mu_B$ at 76 K (Table 1, Fig. 3). This decrease could be also caused by crystal-field effects as well as a cooperative antiferromagnetic interaction of metal ions [1, 2, 9, 10].

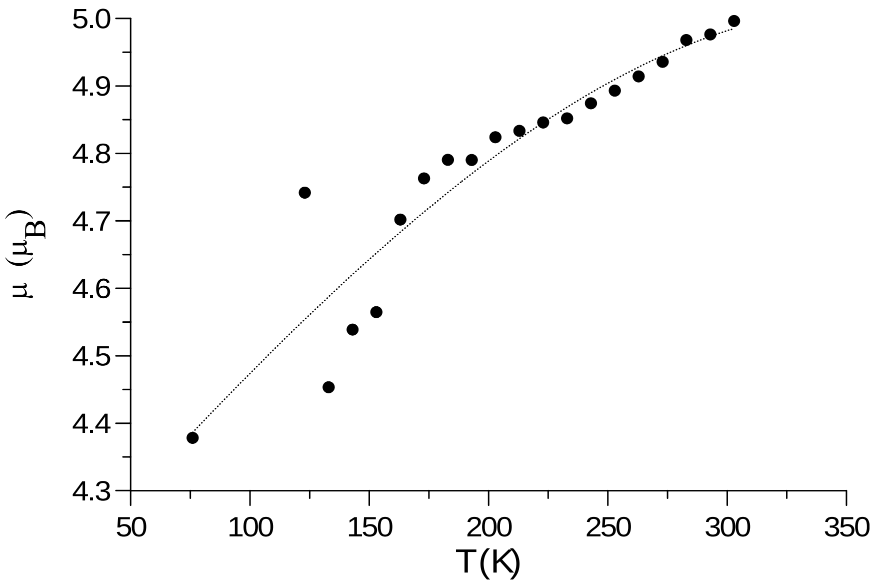

Fig. 3. Experimental magnetic data plotted as magnetic moment μ_{eff} *versus* temperature

The magnetic measurements of $[Nd(H_2O)_5(CuL)_2][CuL]\cdot8H_2O$ in the temperature range of 1.7 – 76 K and the mechanism of the $d-f$ system interaction in this heteronuclear compound will be the subject of future studies.

CONCLUSIONS

A novel heteronuclear compound $[Nd(H_2O)_5(CuL)_2][CuL]\cdot8H_2O$ has been prepared. Its magnetic moment and magnetic susceptibility values decrease with temperature which can be due to crystal field effect and antiferromagnetic interactions of pairs of metal ions.

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