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Studies on properties of Lead Iodide crystals

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ABSTRACT

Lead Iodide single crystals have been grown by gel method by single diffusion method. Various properties have been studied by different researchers; in the present paper Magnetic properties have been studied and reported. Also the proportion of Lead and Iodine calculated by Chemical analysis and reported. In the present course of investigation, the proportion of Lead and Iodine found close to theoretical value.

Keywords: Gel method, Magnetic properties, Chemical analysis.

INTRODUCTION

Regarding the application and work on different properties of Lead Iodide has been already reported [1, 2, 3]. In the present paper, though no.of researchers have worked on different properties of Lead Iodide, it has been decided to work on magnetic properties and estimatin of Lead and Iodine by Chemical analysis of Lead Iodide. Magnetic properties of Lead reviewed carefully and reported herewith.

MATERIALS AND METHODS

Lead Iodide crystals has succesfully grown by gel method. Gel method is very simple and cheap. A.R.grade chemicals have been used throughout the experimental work. Details of the procedure to syntheisize the Lead Iodide has been already reported [1, 2, 3]. Magnetic properties have been carried out by Guoy's method, Chemical analysis and Magnetic properties carried out at Pratap College, Amalner.

RESULTS AND DISCUSSION

Magnetic susceptibility

Solids are classified according to their behaviour in magnetic field as,

1. Diamagmetic
2. Paramagnetic
3. Feffomagnetic

When a substance is placed in a magnetic field, magnetic moment M per unit volume is introduced in the material. Hence, susceptibility χ is defined by equation χ=M/H, where H is applied magnetic field.

Susceptibility is the best specification of magnetic properties of solids. If susceptibility is positive, the substance is paramagnetic, and if it is negative, the substance is diamagnetic.

For determination of magnetic susceptibility the main two methods are (1) Gouy method and (2) Faraday method. In the present work Gouy method (1889) is found to be most suitable

Experimental details

The Gouy set-up should be calibrated, in terms of a substance of known susceptibility such as distilled water, aqueous nickel chloride solution, copper sulphate, mercury tetra thiocyanato cobaltate $Hg[Co(CNS)_4]$ and $[Ni(en)_3]S_2O_3$.

Magnetic susceptibility measurement in the present work were made at room temperature 28^0C using Gouy-balance.

The Gouy tube was calibrated using $Hg[Co(CNS)_4]$ mercury tetra thiocyanato cobaltate (χ_g = 16.44 x 10^{-6} at 20^0C and temperature coefficient for calibrant is –0.05 x 10^{-6} per degree).

First of all the Gouy tube was washed with double distilled water and then by acetone. The tube was dried with an air blower. The empty tube was suspended in the magnetic field and weights of the tube were measured in absence and presence of magnetic field at 2 A current (field strength = 10.000 gauss). Tube correction was calculated. The cleaned tube was filled with the standard calibrant $Hg[Co(CNS)_4]$ carefully by adding small quantity at a time, and tapping it down after each addition. This operation was repeated until the sample was filled into it upto a fixed mark on the Gouy-Tube. The tube was suspended with its bottom at the center of the gap between the two pole faces. Weight of substance was then taken without and with magnetic field at the same field strength. In order to minimize error due to packing of the solid into the tube, measurement with each sample was repeated three to four times. The deviation in weight of the tube (dW) containing 'W' grams of sample was determined. The gram susceptibility was calculated using the expression

$$\chi_g = \frac{\alpha + \beta\, dW}{W}$$

Where α = correction due to air

= KV

where K = susceptibility of standard calibrant and V is volume at 28^0C.

(K = 0.029 x 10^{-6} at 20^0C and 0.0012 x 10^{-6} cgs unit per degree).

B = Tube constant

dW = ΔW - δ, where ΔW is apparent change in weight of the tube containing W grams of substance,

δ = tube correction.

The molar susceptibility $\chi_m = \chi_g$ x molecular weight of substance.

χ^l_m the corrected molar susceptibility was calculated by applying diamagnetic correction of the ligands and anions using Pascal's constants.

Thus; $\chi^l_m = \chi_m$ – diamagnetic correction

Diamagnetic correction for lead iodide was calculated and obtained equal to –99.2 x 10^{-6}.

Observations and results

1	Room temperature	$=28^0$C.
2	Weight of empty tube in air	= 13.03615 gm.
3	Weight of empty tube in field	= 13.03362 gm.
4	Tube correction (δ)	= 0.00253 gm.
5	Weight of (tube + calibrant) in air	= 13.85175 gm.
6	Weight of (tube + calibrant) in field	= 13.89478 gm.
7	Apparent change in weight (ΔW)	= 0.04303 gm.

Calculations for tube constants

Weight of calibrant (W) = 0.8156 gm.

dW = ΔW - δ

= 0.405 + (-0.00253)
= 0.04303 gm.

$$\text{Tube correction} = \beta = \frac{W\chi_g - \alpha}{DW}$$

$$= \frac{0.8156 \times 16.04 \times 10^{-6} - 0.01184 \times 10^{-6}}{0.04303}$$

$$= 303.75049 \times 10^{-6}$$

Table 1 shows the suceptiblity data for Lead Iodide crystals.

Chemical analysis
Chemical analysis of a material means a determination of its elements of the foreign substances, which it may contain. Chemical analysis can be a quantitative analysis.

Experimental Observations
This involves estimation and detection of the metal in the crystals of lead iodide.
1. Estimation of Lead (Procedure)
A) Take the weight of Whatman filter paper (No.41)
B) Dissolve 100 mg of Lead Iodide in 100 ml of water (add few drops of HNO3)
C) Add Sodium acetate and Acetic acid as a buffer in above solution, till PH is 4.5
D) Take 50 ml of above solution in a beaker
E) In the above solution add 2 % solution of Potassium dichromate dropwise (nearly 20 to 25 ml), till yellow precipitate obtained
F) Heat the above content in the water bath about 30 minutes
G) Filter the above content with Whatman filter paper (No.41) and wash the residue with double distilled water and acetone
H) Dry this residue
I) Take the weight of this residue

1) Weight of Whatman filter paper (No.41)	0.9356 gm
2) Weight of Whatman filter and residue	1.0192 gm
3) Weight of residue	0.0650 gm

Calculation of % of Lead in Lead Iodide
A)
PbI2 = Pb
461 = 207
100 mg = 44.90 mg
B)
PbCrO4 = Pb
303 = 207
65.53 mg = 43 mg
C)
44.90 mg = 100 %
43 mg = 93.54 %

2) Estimation of Iodine
Similar procedure adopted to calculate the % of Iodine in Lead Iodide. In place of Potassium dichromate Silver nitrate used.

AgI = Ag
234 = 107
19.283 = 54.54

The proportion of Lead and Iodine was found to match close to theoretical value.

CONCLUSION

From the observations and results is found that Lead Iodide crystals has –ve gram susceptibility (χ_g), indicating thereby that it is diamagnetic. The proportion of Lead and Iodine in Lead Iodide crystals has been calculated in Department of Chemistry, Pratap College, Amalner. The proportion of Lead and Iodine was found to match close to theoretical value.

Table 1 Susceptibility data

Sample	Susceptibility 10 x 10^{-6}
Undoped PbI_2	-0.03147

Table 2 Amounts of Lead and Iodine in Lead Iodide

Amount	Lead	Iodine
Theoretical	44.90	55.100
Practically	42	54.54

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