Experimental Study on Thermophysical Properties in AgCl

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Abstract. For the first time, an experimental study on γ-ray attenuation in AgCl has been taken up to determine the mass attenuation coefficient (μm) and to investigate variation of linear attenuation coefficient, density (ρ), and the coefficients of linear and volume (β) thermal expansions in AgCl in the temperature range 300K-700K.

Keywords: Density, linear and volume thermal expansion coefficients, γ attenuation.

1. Introduction
The experimental investigation of interaction of high energy photons with matter plays a vital role in various fields. The determination of (ρ) and μm in solids as a function of temperature is significant in various applications in science and technology especially at high temperature, and also useful in evaluating the temperature dependence of other thermal properties. The γ-radiation attenuation technique [1] has several advantages over various other methods in evaluating (ρ) and μm at different temperatures in the condensed state, at high temperatures [2-3]. A study on γ-ray attenuation, (ρ) and μm of AgCl at different temperatures has been carried out. The results obtained in this study are compared with the data available in literature obtained by different experimental techniques and mathematical models [4-8].

By narrow collimated beam transmission method [9-10], the author [11] has determined (μm) in solid state compounds at different γ-energies.

2. Experimental Details
The AgCl compound, taken in this work is of (99.6%–99.8%) purity consists 75.26% of Ag and 24.74% of Cl. A 20.0 gm of sample powder is molded into pellet using hydraulic press (figure 1 [12]) at a pressure of 2000 psi. The thickness (l) of sample is 1.40 cm. The design of experimental setup employed here is as in figure 2 [3] and has been described in section 3 [3].

The procedure employed to determine (μm) of AgCl using γ–photons is discussed in section 2 of [11-12]. The pellet was irradiated by γ–photons of 137Cs (0.66MeV). Intensities of the photons transmitted before introducing the sample (Io) and after introducing the sample (I) were detected and
recorded for a duration of \(\frac{1}{4}\) hr, below the peaks of Gaussian distribution using Gamma Detection Apparatus. Block Diagram of Gamma Detection Apparatus is as figure 2 [12] and is described in section 2[12].

The experimental procedure for the study of variation of \((\rho)\), and \((\alpha)\) with temperature using \(\gamma\)-photons is explained in section 2 [13-14]. The experimental study is conducted in the range of 300K-700K.

3. Computational Details
\(\mu\) of \(\gamma\)-photons of 137Cs (0.66MeV) has been determined experimentally using Eqn. 1 [11]. Also calculated mathematically by mixture rule [10] using the relations (2, 3) [11]. The theoretical value of \((\mu)\) has been taken from the database of X-Com [15]. The uncertainty in the \((\mu)\) is estimated from errors in \(I_0, I\) and \((l)\) using the Eqn. 10 [11].

The variation of \(\alpha\), \((\rho)\), \((\alpha)\) and \((\beta)\) with temperature are obtained using the Eqns. (1-10) of sections (2, 4) [14].

4. Analysis of Results
The determined value of \((\mu)\) of AgCl for 137Cs (0.66MeV) \(\gamma\)-beam is \((7.54 \times 10^{-3} \text{ mkg}^{-1})\) are found in good agreement with the theoretical value \((7.59 \times 10^{-3} \text{ mkg}^{-1})\) and calculated value \((7.59 \times 10^{-3} \text{ mkg}^{-1})\). \((\mu}\) depends on photon energy and chemical content.

\((\mu)\) is calculated using Eqn. 2 of section 3 [11]. The results on \((\mu)\) and at different temperatures are being reported for the first time. It can be noticed that the value of \((\mu)\) varies between 41.94m at 300 K and 38.13m at 700 K. Similarly, the \((\mu)\) changes between 5560 kgm-3 at 300 K to a 5054 kgm-3 at 700 K so that decrease is 9.10% in the range. Variation in \((\mu)\) with temperature has been shown in figure 1. The decrease in \((\mu)\) in AgCl with temperature may be due to the increase in thermally generated Schottky defects. However, the \((\mu)\) looks to be not affected much with irradiation of \(\gamma\)-rays since \((\alpha)\) at different temperatures obtained agree well with data reported in the literature. The strength of the source (30 mci) and the duration of the irradiation (~5hrs) in the present work seem to have not affected the equilibrium concentration of defects in AgCl. The \((\alpha)\) values obtained in this investigation have been increasing from 30.41 x 10-6K-1 at 300K to 70.80 x 10-6K-1 at 700K. The comparison between the values of \((\alpha)\) of AgCl in the present study and the values available in the literature has been shown in figure 2. Similarly the \((\beta)\) has been increasing from 8.45 x 10-5K-1 at 300K to 30.4 x 10-5K-1 at 700K.

The temperature dependence of \((\mu)\) has been represented as quadratic equation given by

\[
\mu(T) = (41.69) + (2.502 \times 10^{-3})T + (-1.0307 \times 10^{-5})T^2
\]  (1)

The \((\mu)\) is a negative function of temperature and is given by the second degree polynomial,

\[
\rho(T) = (5527) + (3.316 \times 10^{-1})T + (-1.366 \times 10^{-3})T^2
\]  (2)

The data obtained for \((\alpha)\) has been fit into a third degree polynomial in \(T\) and is given by

\[
\alpha(T) = (55.3 \times 10^{-2}) + (21.2 \times 10^{-2})T + (-6.27 \times 10^{-5})T^2 + (6.5 \times 10^{-8})T^3
\]  (3)

5. Conclusions
Results on \((\mu)\), the variation of \((\mu)\), \((\rho)\) and \((\beta)\) of AgCl in the temperature range 300K-700K have been reported. Variation of \((\mu)\), \((\rho)\) and \((\alpha)\) are indicated by second and third degree polynomials respectively in the temperature range. The variation of \((\alpha)\) with temperature is reported for the first time. The results obtained for the \((\mu)\), \((\rho)\), \((\beta)\) in this investigation are in good agreement with the data in the literature.
6. References

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