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THE THERMAL EXPANSION OF LiH

Allan Zalkin
November 16, 1953

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THE THERMAL EXPANSION OF LiH

Allan Zalkin

November 16, 1953

ABSTRACT

The thermal expansion of LiH was studied in the temperature range of 25° to 525° C. by means of x-ray diffraction. The coefficients of linear expansion were determined as $\alpha = 4.2 \times 10^{-5}$ and $\beta = 1.9 \times 10^{-8}$. There is no evidence of any structure transitions in this range. The cell constant for LiH at 25° C. is $a_0 = 4.083 \text{ \AA}$.

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THE THERMAL EXPANSION OF LiH

Allan Zalkin

November 16, 1953

The thermal expansion of LiH was studied with the use of Cu K α x-rays in the temperature range of 25° to 525° C. The material was heated in a sealed furnace and the back-angle reflection line of lithium hydride, the 333 line, was used for the measurement. LiH has the cubic sodium chloride type structure.

A schematic of the apparatus is illustrated in Figure 1. The furnace block is a stainless steel cylinder, 1-1/2 inches in diameter and 1-1/4 inches long. The sample well is a one millimeter dish, 1/4 inch in diameter, cut into the furnace block. The sample is sealed into the well by squeezing a thin foil window of 3 mil beryllium over a copper gasket by means of a 1/8 inch stainless steel cover plate, thus hermetically sealing the sample. When a .00035 inch foil of Ni was used for the window, it was found to corrode badly with the sample. The sample was backed up in the well with an absorber, like .010 inch rhodium or platinum, in order to cut out the iron fluorescence; the absorber had to be shielded from the corrosive nature of the sample with a .003 inch beryllium covering.

The heating element consisted of 24 ohms of nichrome ribbon (1/8 inch x .001 inch) wrapped on an asbestos form along the length of the furnace. The temperature was followed by means of a chromel-alumel thermocouple inserted into the furnace block to within a millimeter of the sample.

Cu K α x-rays ($\lambda = 1.5418\text{\AA}$) were used, filtered through .0007 inch of Ni. The sample to film distance was from five to six centimeters. The furnace was raised to temperature, and the film was then exposed for two to three hours. According to the thermocouple guage, the temperature was constant on the average to $\pm 10^\circ$ C. The film was measured and the cell constant calculated on the basis of the 333 line. The film to sample distance was calibrated from room-temperature films.

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The Data for three runs is summarized in Table 1.

Table 1.

Run 1*

<u>t (° C)</u>	<u>a₀ (A)</u>
25	4.083
120	4.102
190	4.113
280	4.133

Run 2*

25	4.083
175	4.110
180	4.110
280	4.132
525	4.189

*.00035 inch Ni window; .010 inch Pt absorber.

Run 3**

25	4.083
90	4.092
115	4.097
165	4.108
185	4.111
215	4.118
290	4.134
310	4.139
330	4.142
365	4.152
415	4.166
475	4.179

** .003 inch Be window; .010 inch Rh and .003 inch Be absorber.

The values in Table 1 are plotted; see Figure 2.

These data fit the following empirical formula for linear expansion:

$$a_t = a_{25} [1 + \alpha (t - 25) + \beta (t - 25)^2]$$

$$t = ^\circ\text{C}$$

$$\alpha = 4.2 \times 10^{-5}$$

$$\beta = 1.9 \times 10^{-8}$$

Coefficients of linear expansion

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a_t = cell length at temperature t

a_{25} = cell length at 25°C .

The expansion in lithium hydride is comparable to that found in rock salt:¹

$$\alpha_{\text{NaCl}}^{40^\circ \text{C}} = 4.04 \times 10^{-5}.$$

From powder-pattern measurements, the cell constant of lithium hydride was found to be $4.083 \pm .002 \text{ \AA}$. The literature² value is $4.093 \text{ \AA}$ (converted from kX units by $\times 1.00206$).³ It is possible that the early researchers were not provided with as pure a lithium as is now available; a one to two percent contamination with sodium would account for the difference.

No evidence is present in these data to indicate any phase transitions in the salt in the temperature range from 25° to 525°C . Only the 333 line is observed on the film; however, the plot in Figure 2 shows no discontinuities.

Fig. 1 - SCHEMATIC OF APPARATUS FOR THERMAL EXPANSION MEASUREMENT OF LiH

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Fig. 2 - CELL CONSTANT OF LiH vs. TEMPERATURE

MUL-133

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