## Self-Diffusion in Tin at High Pressure

Table I: Thermal Expan	sion <sup>a</sup> and Linear Compre	ession Coefficients <sup>b</sup> for Tin	× •	a. 5
$\alpha_c$ , deg1	$\kappa_c$ , atm. <sup>-1</sup>	$\Delta \kappa_c$ , deg. " atm1c	$\delta_c$ <sup>45</sup> , atm. <sup>-2</sup>	$\Delta \delta_c$ , deg. <sup>-1</sup> atm. <sup>-2</sup> d
$36.4 \times 10^{-6}$	$6.693 \times 10^{-7}$	$0.0053 \times 10^{-7}$	$4.09 \times 10^{-12}$	$-0.0037 \times 10^{-12}$
$\alpha_a$ , deg. $^{-1}$	κa, atm. −1	$\Delta \kappa_{\alpha}$ , deg. <sup>-1</sup> atm. <sup>-16</sup>	$\delta_a{}^{25}$ , atm. ${}^{-2}$	$\Delta \delta_a$ , deg. <sup>-1</sup> atm. <sup>-2d</sup>
$16.7 \times 10^{-6}$	$6.008 \times 10^{-7}$	$0.0027 \times 10^{-7}$	$4.19 \times 10^{-12}$	$0.0013 \times 10^{-12}$
<sup>a</sup> S. Lee and W. Raynor	, Proc. Phys. Soc., B67, 7	<sup>39</sup> (1954). <sup>b</sup> Ref. 14, p. 16	$59; \ \Delta l/l_0 = \kappa P - \delta P^2.$	$^{\epsilon} \Delta \kappa = \mathrm{d}\kappa/\mathrm{d}T.$ $^{d} \Delta \delta = \mathrm{d}\delta/\mathrm{d}T.$

pressure. The bomb was immersed in a Dow-Corning 500 silicone oil bath at the desired temperature. Crystal temperature was measured on a carefully calibrated chromel-alumel thermocouple near the crystal in the bomb. Temperature was measured to  $0.25^{\circ}$ , but variable temperature gradients prevented knowing the temperature at the crystal to better than within about 2°. Corrections were applied for finite warming and cooling rates. These were always less than 2%.

After the anneal, each nonactive face was microtomed to eliminate surface diffusion effects. The common edge between the two diffusion faces was also removed. Radioactive slices 2  $\mu$  thick were grouped in threes; each group was weighed to  $\pm 10 \ \mu$ g., then counted in a methane flow proportional counter operating in the plateau region. Ten thousand counts above background were collected from each sample. Approximate penetration profiles were determined as shown in Fig. 1. Slice thickness and face misalignment corrections were applied to the diffusion coefficient calculations.<sup>15</sup> The relative error in the diffusion coefficients is close to  $\pm 5\%$ .

## **Experimental Results**

From the thermal expansion and compressibility data given in Table I, the diffusion coefficients were corrected for the effects of thermal expansion and linear compression. This effect is small, never much greater than 1%. At the highest pressures it was occasionally negative or zero. The corrected diffusion coefficients, as well as other pertinent quantities, are given in Table II.

Isobars. A temporary value of  $(\partial \ln D/\partial P)_T$  was taken from a plot of the data as approximate isobars, and this value was used to correct each diffusion coefficient to the nominal (*i.e.*, 000, 2000, etc.) pressure of the run. Corrections were never greater than 3%, so that a more accurate correction procedure is unnecessary. The corrected isobars for *a*- and *c*-axis diffusion are shown in Fig. 2 and 3. The lines shown are not least-squares lines, but are instead intuitive lines which show more clearly the trends in the data. Table II: Diffusion Data  $D_a$ P.  $D_a \times 10^{11}$ ,  $D_c \times 10^{11}$ , kg./cm.2 T, °C. - cm.2/sec. cm.2/sec.  $D_c$ 000 160.4 0.2113 . . . 000 162.6 0.249. . . 000 160.8 0.0986 176.3 0.557 0.255000 2.184 000 191.7 1.400 0.563 2.487000 207 7 3.583 1.558 2.300000 225.8 10.09 4.82 2 093 2158189.6 0.918 0.471 1.949 2.893 1640 207.9 1.360 2.127 7.363 1992 225.6 3.403 2.164 1932 228.8 7.892 4.378 1.803 4116 190.10.800 0.360 3988 192.03907 211.3 2.748 1.293 2.125 225.1 5.124 2.876 4007 1.782 3977 235.9 10.0294.866 2.062 0.5495 6089 190.00.2726035 192.6 0.679 2.496 208.1 1.557 0.701 2.221 6017 2.3006104 224.6 4.883 2.123 10.769 2.567 6020 239.8 4.1960.1834 7999 191.9 0.400 2.181 7909 207.8 0.471 . . . 1.389 2.092208.8 0.664 7959 7970 224.8 3.642 1.507 2.417 8079 239.8 7.691 3.100 2.451 0.3467 0.15910090 192.02.181 10120 207.6 0.9839 0.422 2.33110105 225.32.9101.368 2.127 10134 244.8 7.765 2.7272.847

This is justified since four points are inadequate for a meaningful least-squares treatment, particularly in view of the scatter in the data. Activation energies and  $D_0$  values derived from these isobars are given in Table III. A reasonable mean value of the standard deviations for the activation energies is 1.25 kcal., or 5%, while the relative error of the  $D_0$  values is close to 10%.

<sup>(15)</sup> G. A. Shirn, E. S. Wajda, and H. B. Huntington, Acta Met., 1, 514 (1953).