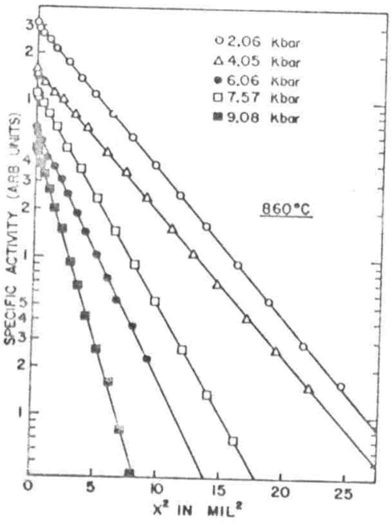


FIG. 3. Penetration curves for self-diffusion in gold at 860°C.

TABLE I. Self-diffusion coefficients for gold.

| Pressure (kbar) | Temperature (°K) | $t_{eff}$ (sec) | $D_T$ (cm²/sec) | $D_i$ (cm²/sec) |
|---|---|---|---|---|
| 0.00 | 1133 | ... | $8.20\times10^{-10}$ | $8.20\times10^{-10}$ |
| 2.06 | 1132 | 10826 | 6.94 | 7.06 |
| 4.05 | 1136 | 10875 | 7.11 | 6.82 |
| 6.06 | 1131 | 7289 | 5.95 | 6.15 |
| 7.57 | 1132 | 10830 | 4.79 | 4.87 |
| 9.08 | 1131 | 6183 | 4.46 | 4.61 |
| 0.00 | 1183 | ... | $1.80\times10^{-9}$ | $1.80\times10^{-9}$ |
| 2.00 | 1194 | 10917 | 1.75 | 1.50 |
| 4.05 | 1184 | 10834 | 1.34 | 1.32 |
| 6.06 | 1182 | 10845 | 1.16 | 1.18 |
| 7.57 | 1182 | 10858 | $8.94\times10^{-10}$ | $9.08\times10^{-10}$ |
| 9.08 | 1181 | 10860 | 8.90 | 9.18 |
| 0.00 | 1233 | ... | $3.73\times10^{-9}$ | $3.73\times10^{-9}$ |
| 4.05 | 1231 | 7202 | 2.70 | 2.78 |
| 6.06 | 1236 | 7240 | 2.77 | 2.66 |

side of the platinum disk. Various portions of the spools were calibrated against a standard Pt-10%-Rh-Pt thermocouple which had been previously calibrated against the melting points of several NBS metals. Final calibrations of the thermocouples used in these runs also showed the deterioration to be irregular, but to a much smaller degree than any of the previous thermocouple configurations.

During the diffusion anneals, the temperature was controlled manually. It was possible to maintain the thermocouple emf reading at the desired value to within 0.02 mV, which would ordinarily correspond to 0.5°C. However, since some runs indicated a gradual thermocouple deterioration, maintaining a constant thermocouple emf was not equivalent to maintaining a constant temperature for these runs. The amount of deterioration was determined by subsequent calibration of the thermocouple. Warm-up time was always 5 min or less, and cooling time was 3 min or less. Corrections, described in Part IV, were made for both. The total effective times for each diffusion anneal are listed in Table I.

The pressure was maintained constant to within 10 bars during warm-up, the extent of the run, and cooling. The pressure was measured with a coil of manganin wire calibrated against the freezing point of mercury at 0°C (7490 bar).

The usual lathe-sectioning and weighing techniques described by Tomizuka[22] were employed. After much trial and error, a lathe tool was ground which made possible the cutting of sections as thin as 0.0002 in., often in the form of a single lathe turning, and leaving behind a mirror-like surface with no burr.

An RIDL model 34-12B 400-channel analyzer and NaI(Tl) scintillation counter were used to count the gamma activity, at the 0.411-MeV peak, of the lathe sections. The live-time counting mode automatically corrected for dead-time, and the usual corrections for background were made.

## III. EXPERIMENTAL RESULTS

Twelve successful diffusion anneals were completed. Penetration plots for each run are shown in Figs. 3–5, and they show that the specific activity decreases exponentially as the square of the penetration distance. The values determined for the diffusion coefficients at each temperature and pressure are listed in Table I, together with temperature-corrected values of the diffusion coefficient $D_i$, and values from the data of Makin, Rowe, and LeClaire.[23] Figure 6 shows a semilogarithmic plot of the temperature-corrected values of

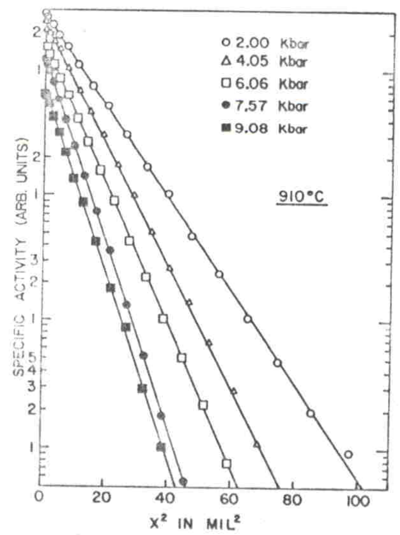


FIG. 4. Penetration curves for self-diffusion in gold at 910°C.

[22] C. T. Tomizuka, in *Methods of Experimental Physics*, edited by K. Lark-Horovitz and V. A. Johnson (Academic Press Inc., New York, 1959), Vol. 6, p. 364.

[23] S. M. Makin, A. H. Rowe, and A. D. LeClaire, Proc. Phys. Soc. (London) B70, 545 (1957).