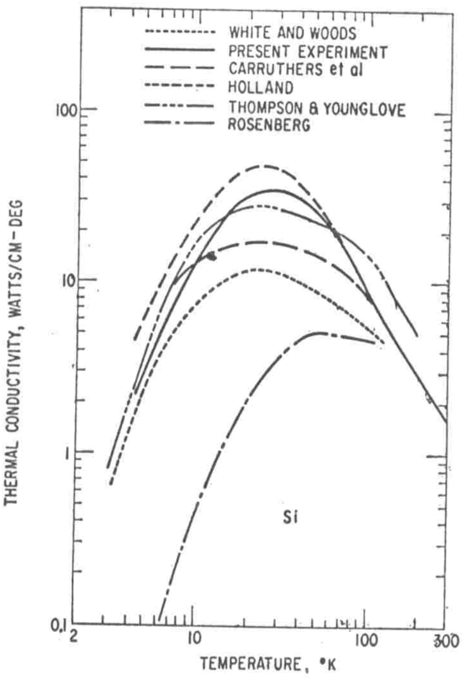

FIG. 6. Comparison of present and previous low-temperature K versus T results for Si.

418 to 1577°K range. The Debye temperature of Si at 674°K is shown for scaling purposes. The melting point, MP, of silicon at 1681°K is only 104°K above the highest point measured.

The results for single crystal Ge are shown in Fig. 5. The points for temperatures between 3.2 and 300°K have been taken from Slack and Glassbrenner.[6] The high-temperature data points between 398 and 1194°K were measured in the present high-temperature apparatus. Neither set of data was adjusted, and again the agreement between the low-temperature and high-temperature data is very good. The Debye temperature θ of Ge is 395°K. These results approach to within 16°K of the melting point, MP, of Ge at 1210°K. The absolute accuracy of both the high- and low-temperature results is computed to be $\pm 5\%$, while the relative accuracy of any two points measured on the same sample is $\pm 2\%$. Table I gives smoothed values for the K of Si and Ge. The low-temperature region where K depends on sample size has been excluded.

TABLE I. Representative values of the thermal conductivity K for high-purity single crystals of silicon and germanium (accuracy $\pm 5\%$).

T°K	K, W/cm deg Si	K, W/cm deg Ge	T°K	K, W/cm deg Si	K, W/cm deg Ge
20		15.	400	1.05	0.44
30		10.5	500	0.80	$0.33\bar{8}$
40		7.7	600	0.64	$0.26\bar{9}$
50	26.	5.9	700	0.52	$0.21\bar{9}$
60	21.	4.7	800	0.43	0.193
70	17.0	3.7	900	$0.35\bar{6}$	0.177
80	13.9	3.1	1000	$0.31\bar{0}$	0.171
90	11.4	$2.5\bar{5}$[a]	1100	$0.28\bar{0}$	0.169
100	9.5	$2.2\bar{5}$	1200	$0.26\bar{1}$	0.173
125	6.0	1.66	1210		0.173
150	$4.2\bar{0}$[a]	1.30	1300	$0.24\bar{8}$	
175	$3.2\bar{5}$	1.10	1400	$0.23\bar{7}$	
200	$2.6\bar{6}$	0.95	1500	$0.22\bar{7}$	
250	1.95	0.73	1600	$0.21\bar{9}$	
300	1.56	0.60	1681	$0.21\bar{6}$	

[a] The bar over the last digit indicates that it is rather uncertain.

PREVIOUS DATA

A. Silicon Below 300°K

A comparison of the present and previous low-temperature K measurements of silicon below 300°K is shown in Fig. 6. Except for the measurements by Thompson and Younglove, all of the measurements agree quite well above 100°K. Some of the variation in K below 100°K is accounted for by boundary scattering in different size samples. However most of the variation in Fig. 6 is caused by phonon scattering from impurities and other crystalline defects. The earliest report of thermal conductivity measurements of silicon at low temperatures of which the authors are aware was made by Rosenberg.[9] He measured a polycrystalline silicon sample over the temperature range 2 to 100°K, and employed gas thermometers to measure the temperature gradient during steady-state heat flow. Scattering by the grain boundaries in his polycrystalline sample is probably the reason that Rosenberg's K results are much lower than any of the others. White and Woods[10] have measured a single crystal silicon sample (room-temperature resistivity 6.7 Ω-cm) over a temperature range of 2 to 100°K. The impurities present in this sample were not stated. Thompson and Younglove,[11] in the temperature interval 2 to 200°K, have measured several samples of silicon doped with boron or arsenic. Figure 6 shows their measurement of their most highly doped silicon sample (boron doped with a room-temperature resistivity of 2000 Ω-cm). Carruthers *et al.*[12] have measured the thermal conductivity of a high-purity single crystal silicon sample, n type from 2 to 300°K. The net carrier concentration was 5×10^{14} at 300°K. Holland[13] measured the thermal conductivity of several silicon samples containing different amounts of oxygen and has discussed the effect of oxygen as a scatterer of phonons to reduce the thermal conductivity. His measurements of an n-type sample with the least amount of oxygen ($<10^{16}$ cm^{-3}) and a room-temperature resistivity of 260 Ω-cm agree very closely with the present experiment.

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