TABLE III. Elastic stiffness coefficients of molybdenum.

Temp (°C)	C_{11} 10^{12} dyn·cm^{-2}	C_{12} 10^{12} dyn·cm^{-2}	C_{44} 10^{12} dyn·cm^{-2}
−200	4.730±0.094	1.562±0.099	1.109±0.0024
−100	4.688±0.083	1.569±0.088	1.101±0.0021
0	4.637±0.085	1.578±0.090	1.092±0.0021
+100	4.578±0.089	1.581±0.095	1.082±0.0022
200	4.522±0.092	1.587±0.096	1.072±0.0023
300	4.462±0.092	1.592±0.096	1.062±0.0023
400	4.403±0.094	1.598±0.099	1.051±0.0023
500	4.345±0.091	1.609±0.096	1.040±0.0022
600	4.280±0.086	1.610±0.090	1.029±0.0021
700	4.215±0.082	1.613±0.086	1.018±0.0020

towards an isotropic behavior as temperature increases.

DISCUSSION

Several investigators have reported room temperature values for the single-crystal elastic constants of molybdenum, and two of them have also made measurements over a limited temperature range.

The room-temperature values of the elastic coefficients of molybdenum determined during previous investigations along with those determined during this study are shown in Table IV. The agreements between the pulse-transmission and thin-rod resonance values determined during the present investigation and the values reported by Bolef and de Klerk[5] are very good. The results reported by Druyvesteyn[6] are surprisingly close to these values considering that he worked with rolled sheet having a "clear texture," since single crystals of molybdenum were not available at that time (1941). The values of the elastic constants reported by Featherston and Neighbors[7] are in considerable disagreement with those of all the other

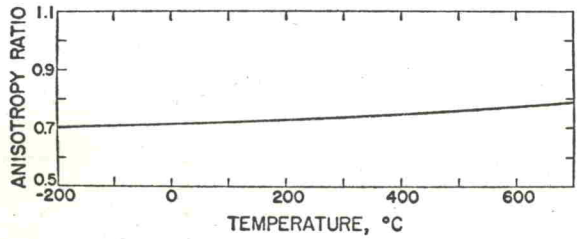

FIG. 8. The anisotropy ratio of molybdenum as a function of temperature.

investigators. The reasons for the disagreement are not completely apparent, although as they pointed out, the molybdenum used in that investigation was of low purity, e.g., containing 920 ppm oxygen.

The C_{ij}'s calculated from the data of Bolef and de Klerk, and those of Featherston and Neighbours were plotted along with those from this investigation as functions of temperature in Figs. 3, 4, and 5. Although Bolef and de Klerk did not mention it, the C_{12} curve calculated from their data shows an increase in value as temperature increases in agreement with the present results. A linear extrapolation of the C_{ij} curves to absolute zero was made. Since the elastic stiffness coefficients approach absolute zero with zero slope the values of the C_{ij}'s at zero should lie between the extrapolated values and the measured values at −198°C. Table V contains these data at the two temperatures and their averages. Since the difference between the values at these temperatures is small for molybdenum their averages should be good approximations of the true values at absolute zero.

The usefulness of averaging techniques to determine the elastic moduli, E and G, for a polycrystalline material from the single-crystal elastic constants is being recognized by many investigators as a useful technique. The moduli that the material would have if it were isotropic has considerable value from a practical standpoint. Using Kröner's[8] method of averaging the Voigt[9] and Reuss[10] averages such calculations were

TABLE IV. Room-temperature elastic properties of Mo.

Investigation	Units of 10^{12} dyn·cm^{-2}					
	C_{11}	C_{12}	C_{44}	C'	K	A
Featherston and Neighbours	4.4078	1.724	1.216	1.342	2.619	0.91
Bolef and de Klerk	4.696	1.675	1.068	1.510	2.683	0.71
Druyvesteyn	4.6	1.79	1.09	1.4	2.73	0.78
Present, thin rod	4.63	1.61	1.09	1.51	2.62	0.72
Present, pulse echo	4.62	1.58	1.09	1.52	2.59	0.72

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