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The determination of the elastic constants of silicon by diffuse X-ray reflexions. By S. C. PRASAD and W. A. WOOSTER, *Crystallographic Laboratory, Cavendish Laboratory, Cambridge, England*

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Introduction

A disc of silicon, 18 mm. diameter, 1 mm. thick and cut parallel to the (100) plane, was loaned to the authors by Dr E. Billig, of the Associated Electrical Industries Laboratories, Aldermaston, Berks. The disc had been cut perpendicular to the growth direction from a large monocrystalline ingot which was pulled from a melt of hyperpure silicon by a special technique developed at the A.E.I. Laboratories. This technique consists essentially of an adaptation of the Czochralski method to deal with highly reactive materials at high temperatures, special care being taken to avoid contamination of the melt and straining of the ingot. This specimen was used in conjunction with a Geiger-counter spectrometer in the manner already described (Ramachandran & Wooster, 1951*a*, *b*) to determine the intensity of scattering from small volume elements of reciprocal space along lines (rekhas) passing through the reciprocal point (relp) 400. The rekhas chosen were parallel to [100], [010] and [110]. The intensity of first-order diffuse scattering is proportional to the reciprocals of c_{11} and c_{44} for the rekhas [100] and [010] respectively. The corresponding intensity for the rekha parallel to [110] is proportional to

$$\frac{1}{c_{11}-c_{12}}+\frac{1}{c_{11}+c_{12}+2c_{44}}\,.$$

Thus from the measurement on the rekha parallel to [110] the third constant c_{12} can be determined.

Experimental results

The results of observations along the three rekhas parallel to [100], [010] and [110] passing through the relp 400 are given in Table 1 (R is expressed in centimetres on a representation of the reciprocal lattice for which unit distance = 50 cm.).

Table 1

R (cm.)	$1/R^2$ (cm.$^{-2}$)	I (counts in 5 min. for direction of rekha) [100]	[010]	[110]
4·5	0·0494	43·3	55·6	57·3
3	0·111	62·2	105·8	110·9
2	0·25	117·5	193·2	204·3
1·5	0·444	177·3	327·9	325·7
1·25	0·64	246·3	—	—
Background		24	24	24
Slope of line I versus $1/R^2$		345	690	712

Corrections were made for divergence, though only the ψ correction exceeds 1%. A correction of 2% was applied on account of the second-order diffuse scattering.

The ratios of the elastic constants found from these results were as follows:

$$c_{12}/c_{11} = 0{\cdot}39_3,\quad c_{44}/c_{11} = 0{\cdot}50\,.$$

It is estimated that the accuracy of the elastic ratios is 5%. The compressibility of silicon is given by Bridgman (1948) as

$$\beta = 1{\cdot}001\times10^{-12}\ \text{cm.}^2\ \text{dyne}^{-1},$$

and since $\beta = 3/(c_{11}+2c_{12})$ we may combine this value with the ratios given above to obtain the values

$$c_{11} = 16{\cdot}8,\quad c_{12} = 6{\cdot}6,\quad c_{44} = 8{\cdot}4\times10^{11}\ \text{dyne cm.}^{-2}.$$

McSkimin, Bond, Buehler & Teal (1951) and McSkimin (1953), using an ultrasonic method, have also determined the elastic constants of silicon and the values obtained are

$$c_{11} = 16{\cdot}57,\quad c_{12} = 6{\cdot}39,\quad c_{44} = 7{\cdot}96\times10^{11}\ \text{dyne cm.}^{-2}.$$

The values obtained in the present investigation using a frequency of approximately 10^{11} Hz. do not differ significantly from those obtained by McSkimin at ultrasonic frequencies.

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Bragg reflexion of polarized X-rays from a perfect absorbing crystal. By K. S. CHANDRASEKHARAN, *Department of Physics, University of Madras, Madras 25, India*

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The dynamical theory of X-ray reflexion leads to the well known result that in the case of a surface reflexion from a perfect non-absorbing crystal, the integrated reflexions, obtained with X-rays polarized with the vibration direction parallel and perpendicular to the plane of scattering, are in the ratio of $|\cos 2\theta|:1$, where θ is