ozone and on the superoxide ion. In the case of ozone, with $r_{O-O} = 1{\cdot}278$ Å. Trambarulo *et al.* (1953) show the most likely bond order to be 0·5. Magnetic susceptibility measurements suggest (Pauling, 1940) the superoxide ion contains a three-electron bond, $[\ddot{\underset{..}{O}}\cdots\ddot{\underset{..}{O}}]^-$, and thus this bond, with $r_{O-O} = 1{\cdot}28$ Å, should also have an order of about 0·5. The resulting curve is then very similar to the corresponding order/length curve for carbon.

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The Determination of the Elastic Constants of Germanium by Diffuse X-ray Reflexion

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The elastic ratios c_{12}/c_{11} and c_{44}/c_{11} have been measured by the diffuse reflexion of X-rays from a single crystal of germanium. The values obtained were respectively 0·38 and 0·52. When these results are combined with the already known cubic compressibility the elastic constants can be evaluated as $c_{11} = 13{\cdot}3$, $c_{12} = 5{\cdot}1$, $c_{44} = 7{\cdot}0 \times 10^{11}$ dyne cm.$^{-2}$.

Introduction

A crystal of germanium with a circular face of 12 mm. diameter cut parallel to the (100) plane was loaned to the authors by Prof. Lark Horowitz, Purdue University, Indiana, U.S.A. The crystal was etched to remove the imperfection on the surface. This was used in conjunction with a Geiger-counter spectrometer in the manner already described (Ramachandran & Wooster, 1951) 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

$$1/(c_{11}-c_{12})+1/(c_{11}+c_{12}+2c_{44}) .$$

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, using Cu $K\alpha$ radiation are given in Table 1 (R is expressed in cm. on a representation of the reciprocal lattice such that the radius of the reflecting sphere for Cu $K\alpha$ radiation is 50 cm.).

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:

$$c_{12}/c_{11} = 0{\cdot}38(1), \quad c_{44}/c_{11} = 0{\cdot}52(4) .$$

Table 1

R	$1/R^2$	I (counts in 5 min.) for rekha parallel to [100]	[010]	[110]
4·5	0·0494	98	133	139
3·0	0·111	149	236	235
2·0	0·25	257	434	460
1·5	0·444	401	719	720
1·25	0·64	590	—	—
Mean slope of the straight line		783	1493	1587
Background count		60	60	60

It is estimated that the accuracy of the elastic ratios is 5%. The compressibility of germanium is obtained by extrapolating the Bridgman (1949) values to zero pressure:

$$\beta = 12{\cdot}79 \times 10^{-13} \text{ cm.}^2 \text{ dyne}^{-1}.$$

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

$$c_{11} = 13{\cdot}3,\ c_{12} = 5{\cdot}1,\ c_{44} = 7{\cdot}0 \times 10^{11} \text{ dyne cm.}^{-2}.$$

Bond *et al.* (1950) and McSkimin (1953), using an ultrasonic method, have also determined the elastic constants of germanium and the values obtained were as follows:

	c_{11}	c_{12}	c_{44}
Bond, 1st crystal	12·92	4·79	6·70
2nd crystal	12·98	4·88	6·73
McSkimin	12·89	4·83	6·71

The elastic ratios obtained from these values agree very well with those obtained in the present investigation; however, the absolute values are about 4% higher. The values obtained in the present investigation, using a frequency of approximately 10^{11}, do not differ significantly from those obtained by the previous workers at ultrasonic frequencies.

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Precession Goniometry to Identify Neighboring Twins

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The two limiting circles which appear on a properly chosen orientation picture, taken with the precession camera, are used to identify the twin law in the case of neighboring twins.

Whenever the crystal lattice or one of its multiple lattices possesses pseudo-symmetry, the crystal may twin (twinning by pseudo-merohedry or by reticular pseudo-merohedry). If the pseudo-symmetry of the 'twin lattice' is pronounced and sufficiently high, several twin laws may lead to nearly identical orientations of the twinned individual. The resulting twins have been called 'neighboring twins' (*macles voisines*, Friedel, 1926). Because the relative orientation of one of the twinned crystals with respect to the other is known to morphologists only within the limits of error of optical goniometry, the identification of neighboring twins may be a difficult problem, as is well illustrated by cryolite, staurolite, harmotome, morvenite, etc. During a study of staurolite twinning (Hurst, Donnay & Donnay, 1955), an X-ray procedure for such an identification was developed. It makes use of the precession camera (Buerger, 1944).

If reflection in (hkl) is a possible twin law, the twin is adjusted on the precession instrument so that the X-ray beam lies in (hkl). The zero level to be photographed then contains $[hkl]^*$. *If* (hkl) *is* the twin plane, $[hkl]^*_{\mathrm{I}}$ and $[hkl]^*_{\mathrm{II}}$ coincide so that $[hkl]^*$ shows as a single row of reflections. (The subscripts I and II