Imperial College of Science and Technology, London, and for his constant encouragement.

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Elastic Constants of Diamond

In a recent communication in *Nature*, Krishnan, Chandrasekharan and Rajagopal[1] suggest that discrepancies between the determinations of the elastic constants of diamond may find an explanation in the enlarged scheme of elastic constants suggested by Laval, LeCorre, Viswanathan and Raman. In referring to the results of the experiments by Prince and Wooster[2], they suggest that "probably the theory of diffuse scattering of X-rays needs some modification in the light of the new theory of elasticity".

In the following communication, we indicate what changes the new theory of elasticity introduces into the interpretation of the measurements of Prince and Wooster, with the same notation as used in their paper, and using for the new theory the notation of the Indian school (which differs from the one originally introduced by Laval in that their d_{45} is his N_{47}, etc.). The change introduced by the new theory consists in the coupling together of d_{12} and d_{45} to form an inseparable pair of constants. For example, the experiments on a 110 reflexion enable the intensities of diffuse scattering from points along the [110] and [001] directions to be compared. The corresponding K-ratio, $K[110]_{220}/K[001]_{220}$, is in the old theory : $2c_{44}/(c_{11}+c_{12}+2c_{44})$, and in the new theory : $2d_{44}/\{d_{11}+d_{44}+(d_{12}+d_{45})\}$. Similar changes are introduced into the other K-ratios.

On the old theory the following ratios for the elastic constants were found :

$$c_{12}/c_{11} = 0{\cdot}30 \pm 0{\cdot}02, \quad c_{44}/c_{11} = 0{\cdot}40 \pm 0{\cdot}02$$

We repeated the calculations using this time the formulæ of the new theory, and obtained for the new ratios :

$$(d_{12}+d_{45})/d_{11} = 0{\cdot}70 \pm 0{\cdot}02, \quad d_{44}/d_{11} = 0{\cdot}40 \pm 0{\cdot}02$$

The absolute value of the constant d_{44} was measured by Prince and Wooster using the intensity of Compton scattering as the standard. This gave a value of $(44 \pm 2{\cdot}5) \times 10^{11}$ dyn. cm.$^{-2}$. (These units will be used throughout this communication.) Using the above ratio for d_{44}/d_{11}, the value :

$$d_{11} = 110 \pm 11$$

is obtained. To proceed further, it is necessary to consider the bulk modulus of elasticity. The bulk modulus, k, is connected with the elastic constants by the equation :

$$k = (d_{11} + 2d_{12})/3$$

The value of k given by Adams[3] is 63, and by Williamson[4], 56. They lead to the following values of d_{12} :

$$\begin{aligned} d_{12} &= 39 \pm 6 \text{ (Adams)} \\ &= 29 \pm 6 \text{ (Williamson)} \end{aligned}$$

Now, $d_{12} + d_{45} = (0{\cdot}70 \pm 0{\cdot}02)d_{11} = 77 \pm 10$, and hence :

$$\begin{aligned} d_{45} &= 38 \pm 16 \text{ (Adams)} \\ &= 48 \pm 16 \text{ (Williamson)} \end{aligned}$$

Table 1 summarizes the results calculated according to the two theories :

Table 1

Old theory	New theory (with Adams's k)	New theory (with Williamson's k)
$c_{11} = 110 \pm 11$	$d_{11} = 110 \pm 11$	110 ± 11
$c_{12} = 33 \pm 5$	$d_{12} = 39 \pm 6$	29 ± 6
$c_{44} = 44 \pm 2{\cdot}5$	$d_{44} = 44 \pm 2{\cdot}5$	$44 \pm 2{\cdot}5$
	$d_{45} = 38 \pm 16$	48 ± 16

Unfortunately, the uncertainty in the diffuse X-ray measurements, combined with the uncertainty in the measurement of the compressibility, make it impossible to establish a significant numerical difference between d_{44} and d_{45}. The same uncertainty in the compressibility affects all the calculations of d_{45} based on the dynamically measured $(d_{12} + d_{45})$. Consequently it is hard to see how any experimental proof can at this stage be given that the classical three elastic constants are insufficient for diamond, and that the four constants of the new theory have to be applied to it.

Quite apart from these experimental considerations, we have suggested in a recent communication[5] that in those cases where the Laval theory is applicable the number of independent elastic constants is not 45 but 39. For the Laue-group $m3m$, to which diamond belongs, the number of independent elastic constants turns out to be three, the same as in the classical theory.

Furthermore, it is difficult to accept the view that a separation of the results of methods that are all essentially dynamic, into 'static constants' and 'wave (dynamic) constants', can be made in the way suggested in the communication by Krishnan *et al.*[1].

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Errors in the Measurement of Film Thickness by Multiple-Beam Interferometry

The Tolansky[1] method for the measurement of the thickness of thin films by multiple-beam interference techniques is now well established. Briefly, the film, the thickness of which is to be measured, is deposited on a flat, smooth substrate. The film should have a sharp edge so that a step is formed when the film and the adjacent substrate are coated with an opaque, highly reflecting metallic layer. The height of this step is measured by using the highly reflecting layer as one surface of an interferometer and viewing the multiple-beam fringe system by reflexion. Provided that the overlayer assumes the exact contour of the surface, this step-height will give the thickness of the film underneath.

There are two ways in which a sharp edge can be given to an evaporated film. Part of the substrate can be shielded during the deposition of the film, the shield being removed for the deposition of the overlayer. Alternatively, Scott, McLauchlan and