PHOTO-ELASTIC BEHAVIOUR OF CUBIC CRYSTALS

Displacement of Principal Axes Caused by Linear Stresses

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Received April 20, 1953

1. Introduction

In a previous paper by one of us (1953), it has been shown that linear stresses will cause the principal axes of certain sections of the optical ellipsoid to be tilted and it was pointed out that this effect may be used for distinguishing the T and T_h classes of crystals from the T_d, O and O_h ones in the cubic system. The results of experiments conducted by us with barium and lead nitrates (T_h class), ammonium and potassium alums (T_h class) and fluorite (O_h class) are given in this paper. In all these cases, except lead nitrate, prisms already cut and prepared by Suryanarayana (1948) in this laboratory have been used. Crystals of lead nitrate are freshly grown and prisms are now prepared for the purpose of these studies. The photo-elastic constants assumed and used in calculating the θ values as per formulæ given in the preceding paper already referred to (1953) are given in Table I. In Table II, the measured values of θ are compared with the calculated ones.

2. Method of Measurement

In all cases, the appropriate prism is held between two crossed nicols mounted on graduated circles. The prism is subjected to a linear compressional stress along one of its axes, the vertical one in practice. The direction of observation is horizontal and perpendicular to the stress direction. If there is a tilt of the principal axes in the section perpendicular to the direction of observation, the reference line being the stress direction, restoration of light is immediately noticed and the tilt may be measured by suitably rotating the pair of crossed nicols to a new position of extinction. In individual cases, several readings are taken and the averages arrived at but the angles given in Table II may be taken generally as good enough only to a degree. In some, where the prisms are small and the observation difficult, errors are larger,

3. RESULTS

TABLE I

Photo-Elastic Constants

	Barium nitrate	Lead nitrate	Ammonium alum	Potassium alum	Fluorite
$-(q_{11}-q_{12})$ ..	23·84	19·13	5·93	5·21	1·45
$-(q_{11}-q_{13})$ ..	17·13	11·84	5·25	4·64	"
$-q_{44}$ ..	1·69	1·39	1·15	0·63	−0·70

Units of 10^{-13} C.G.S.

TABLE II

Angular Tilts

Description of the measurement	Barium nitrate		Lead nitrate		Ammonium alum		Potassium alum		Fluorite	
	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.
Stress along $[\bar{2}11]$ Obs. along $[0\bar{1}1]$	29°	30° 43′	26°	30° 18′	25°	23° 57′	26°	28° 12′	38°	35° 40′
Stress along $[\bar{2}11]$ Obs. along $[111]$	11°	6° 51′	6°	9° 32′	4°	2° 8′	3°	2° 17′	..	..
Stress along $[0\bar{1}1]$ Obs. along $[111]$	11°	6° 51′	7°	9° 32′	4°	2° 8′	4°	2° 17′	..	..
Stress along $[01\bar{1}]$ Obs. along $[\bar{2}11]$	12°	14° 48′	17°	19° 15′	6°	4° 11′	5°	4° 55′	0	0
Stress along $[110]$ Obs. along $[001]$	30°	31° 38′	30°	34° 34′	13°	8° 15′	8°	12° 10′	..	..
Stress along $[\bar{1}10]$ Obs. along $[001]$	34°	31° 38′	32°	34° 34′	4°	8° 15′	6°	12° 10′	..	..

4. Discussion of Results

The notable features of Table II are that even fluorite which belongs to the O_h class shows the effect in one case, as should be expected, and the measured angle agrees with the calculated one (first row). In other cases as well, the agreement between the observed and calculated values is fair. All orientations, except the one contained in the first row, serve to distinguish between the T and T_h classes on the one hand and the T_d, O and O_h on the other. The distinction is clear-cut, easy to observe and to measure. In certain cases, for example the second and third rows, the calculated effect is the same in magnitude and this is a result of the symmetry. Observed values confirm this conclusion to a fair degree of accuracy in several cases. Similar remarks apply to the fifth and the sixth rows.

5. Summary

The paper furnishes measurements in respect of the tilts observed of the principal axes in sections of the optical ellipsoid caused by linear stresses applied to prisms cut out of different cubic classes of crystals. In most cases, such effects are characteristic only of the T and T_h classes and are absent in the T_d, O and O_h classes. They serve, therefore, to distinguish between the two types. There is a fair agreement between the measured and calculated values in practically all the cases studied.

References

Bhagavantam, S. .. See foregoing paper (1953).

Suryanarayana, D. .. Thesis submitted to the Andhra University (1948).