

Table 1. *Stacking fault energies*

Polytype	Zhdanov symbol	Theoretical stacking fault energy*
12R	[13] <sub>3</sub>	$E_a = 2E_2 + E_3 + 4E_4 + 3E_5 + 4E_6 + 4E_7 + 8E_8 + \text{---}$
24R	[2213] <sub>3</sub>	$E_b = 2E_2 + E_3 + 4E_4 + 2E_5 + 5E_6 + 3E_7 + 8E_8 + \text{---}$
30R	[221212] <sub>3</sub>	$E_c = 2E_2 + 4E_4 + 2E_5 + 6E_6 + 2E_7 + 7E_8 + \text{---}$
36R	[22112121] <sub>3</sub>	$E_d = 2E_2 + 4E_4 + 2E_5 + 6E_6 + 3E_7 + 7E_8 + \text{---}$
42R	[(22) <sub>2</sub> 1212] <sub>3</sub>	$E_e = 2E_2 + 4E_4 + 2E_5 + 6E_6 + 2E_7 + 7E_8 + \text{---}$
60R	[(22) <sub>3</sub> 1223] <sub>3</sub>	$E_f = 2E_2 + 4E_4 + 2E_5 + 6E_6 + E_7 + 8E_8 + \text{---}$
72R	[(22) <sub>4</sub> 1223] <sub>3</sub>	$E_g = 2E_2 + 4E_4 + 2E_5 + 6E_6 + E_7 + 8E_8 + \text{---}$

\* The fault energy is represented by the number of pairs of separation  $N$  which are not in proper stacking sequence compared to the common structure sequence multiplied by the distortional energy  $E_N$  per pair. They present  $(n/3) H \rightarrow nR$  transformation energy per  $\frac{1}{3}$  of the unit cell of  $nR$  type.

than the latter. This implies a great abundance of polytypes of the former series, which agrees fully with experimental observations. The known members of series [(22)<sub>n</sub> 13]<sub>3</sub> are the types 12R and 24R and of the other series [(22)<sub>n</sub> 1212]<sub>3</sub>, 30R and 42R. Of 12R and 24R, the former occurs more abundantly than the latter because the energy required for the creation of mixed dislocations generating 12R and 24R, as proportional to the square of their Burgers vector whose magnitudes are  $[c^2 + \frac{1}{3}a^2]^{1/2}$  and  $[(2c)^2 + \frac{1}{3}a^2]^{1/2}$ , respectively, is evidently less for the former than the latter. This also explains the rare occurrence of higher polytypes which otherwise, on the stacking fault energy considerations alone (Table 1), should occur very frequently. The polytype 36R can be explained in terms of a mixed dislocation of Burgers vector  $(2c' + a/3 + 2b/3)$  where  $c' = 3c/2$ . The formation of 60R and 72R can be understood by considering the cooperation of two screw dislocations of the same hand along with a partial edge dislocation. For any  $nR$  polytype, since every  $n/3$ th layer is part of the same spiral surface extending throughout the crystal, any stacking fault once generated in a layer will expand along the appropriate spiral surface to the  $n/3$ th,  $2n/3$ th,  $n$ th,  $\dots$ , neighbouring layer, thereby causing a periodic repeated slip.

The rhombohedral structures are found to occur almost on the upper face of the crystals. This is significant in the

sense that the screw dislocations are generated towards the later stages of the growth as the high energy required for their creation can be available from the crystal only when it has grown to a considerable volume whereas edge dislocations may be created at any stage of the growth.

Recently Prasad & Srivastava (1971) have calculated theoretical stacking fault energies of 60R, 72R, and 32H and have shown that it is minimum for the proposed structures and consequently a new possible method of determining atomic structures has been suggested. But, from stacking fault energy considerations alone, it is found that rhombohedral polytypes should possess the structures [(22)<sub>n</sub> 13]<sub>3</sub>, not the proposed structures. Therefore, the stacking fault energy criterion alone is of limited value in determining the atomic structures of polytypes.

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**Thermal expansion of strontium molybdate** By V. T. DESHPANDE and S. V. SURYANARAYANA, *Physics Department, College of Science, Osmania University, Hyderabad-7, India*

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A precise X-ray determination of the lattice parameters of strontium molybdate ( $\text{SrMoO}_4$ ) has been made in the temperature range 26 to 658°C. Using these data the coefficients of the lattice thermal expansion,  $\alpha_a$  and  $\alpha_c$ , along and perpendicular to the tetragonal axis respectively, have been evaluated. The temperature dependence of these coefficients could be expressed in the following forms:  $\alpha_a = 6.58 \times 10^{-6} + 10.62 \times 10^{-9}t - 1.25 \times 10^{-12}t^2$  °C<sup>-1</sup>,  $\alpha_c = 16.43 \times 10^{-6} + 20.26 \times 10^{-9}t - 8.16 \times 10^{-12}t^2$  °C<sup>-1</sup>. Here  $t$  is the temperature in degrees Celsius.

Recently we have studied the temperature variation of the lattice parameters and the principal coefficients of thermal expansion of a number of scheelite type compounds. The data obtained on some of the compounds have already been published [ $\text{KIO}_4$  (Deshpande, Pawar & Suryanarayana, 1967);  $\text{NaIO}_4$  (Deshpande, Suryanarayana & Pawar, 1968);  $\text{CaMoO}_4$  (Deshpande & Suryanarayana, 1969a);  $\text{CdMoO}_4$

(Deshpande & Suryanarayana, 1969b);  $\text{SrWO}_4$  (Deshpande & Suryanarayana, 1969c) and  $\text{BaWO}_4$  (Deshpande & Suryanarayana, 1970)]. The present note reports similar results obtained on strontium molybdate,  $\text{SrMoO}_4$ . No published work on either the macroscopic expansion or the lattice expansion measurements on this solid, is available in the literature.

Small chips of SrMoO<sub>4</sub> crystals were crushed to fine powder form. The specimen for the X-ray diffraction work was prepared by putting this powder in a thin walled quartz capillary tube of about 0.5 mm inner diameter. Powder photographs were taken, using a Unicam high temperature camera and Cu K radiation, at eight different temperatures in the range 26 and 658°C. The experimental technique used was the same as described in an earlier paper (Deshpande & Pawar, 1962).

Table 1 gives the values of the lattice parameters of SrMoO<sub>4</sub> at different temperatures along with the standard errors evaluated by the method of Jette & Foote (1935). The values of the standard errors have been found to change with temperature in a random way as the number of reflexions used to evaluate the lattice parameters varied from film to film.

Table 1. Values of the lattice parameters of SrMoO<sub>4</sub> at different temperatures

Temperature	<i>a</i>	<i>c</i>
26°C	5.3964 (2) Å	12.0232 (4) Å
165	5.4015 (18)	12.0531 (39)
267	5.4081 (7)	12.0784 (15)
315	5.4097 (8)	12.0932 (13)
361	5.4134 (11)	12.1043 (19)
461	5.4174 (11)	12.1333 (19)
563	5.4240 (12)	12.1572 (23)
658	5.4302 (3)	12.1898 (8)

The values of the principal coefficients of thermal expansion at different temperatures were determined by the procedure suggested by Deshpande & Mudholkar (1961)

and the following expressions were obtained by the usual method of statistical treatment:

$$\alpha_a = 6.58 \times 10^{-6} + 10.62 \times 10^{-9}t - 1.25 \times 10^{-12}t^2 \quad ^\circ\text{C}^{-1}$$

$$\alpha_c = 16.43 \times 10^{-6} + 20.26 \times 10^{-9}t - 8.16 \times 10^{-12}t^2 \quad ^\circ\text{C}^{-1}$$

Here  $\alpha_a$  and  $\alpha_c$  are the coefficients of expansion at  $t$  °C parallel to the  $a$  axis and the  $c$  axis respectively. Both the coefficients are found to increase with temperature and the coefficient along the  $c$  axis is greater than the other at all temperatures studied.

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### Book Reviews

*Works intended for notice in this column should be sent direct to the Book-Review Editor (M. M. Woolfson, Physics Department, University of York, Heslington, York YO1 5DD, England). As far as practicable books will be reviewed in a country different from that of publication.*

**Materialprüfung mit Röntgenstrahlen.** By RICHARD GLOCKER. Pp. viii. + 631. Berlin: Springer Verlag, 1971. Preis (Gebunden, DM 98; U.S. \$27.00.

Von alters her war der 'Glocker' eine Bibel für die Anwendung von Röntgenstrahlen bei der Materialprüfung. Von dem von 1927 datierenden Buch ist dies die 5e Auflage, die mit Abschnitten über u.a.m. Mikrosonde, Gitterstörungen und Mischkristalle ergänzt worden ist. Das Buch gibt jetzt einen sehr vollständigen Überblick aller Anwendungen und als solches ist es ein sehr gutes Nachschlagewerk. Man kann sich jedoch fragen, ob in dieser Zeit 'Grobstrukturuntersuchung' (40 Seiten) noch in *einem* Buch zusammen mit der Fourier Analyse von Schmelzen und der Theorie vom Parakristall gehört.

Nebst den Grundlagen der Erregung und der Diffraktion von Röntgenstrahlen hat das Buch Abschnitte u.a. über: *Grobstrukturuntersuchung*: in 21 Seiten.

*Spektralanalyse*: vom Siegbahn'schen Spektrographen bis zu der modernen Fluoreszenz-spektrometrie (48 Seiten) und der Mikrosonde (10 Seiten).

*Feinstrukturuntersuchung*: 323 Seiten im Total.

Was die Diffraktionsmethode betrifft, ist es auffallend, dass die Einteilung photographische Methode gegenüber Zahlrohrmethoden gemacht ist, so dass z.B. die Pulvermethode auf diese zwei Abschnitte verteilt wird, ebenso wie die Einkristallstrukturanalyse. Die photographischen Pulveraufnahmen, einschliesslich fokussierender Kameras nehmen 30 Seiten in Anspruch.

Man kann bemerken, dass das Buch den ausgedehnter beschriebenen 'alten' Methoden durch Hinzufügung von modernen Methoden 'angepasst' ist. So wird die sogar in den 30er Jahren kaum angewandte Sauter'sche Kamera auf zwei Seiten beschrieben, die Einkristall-Zahlrohrgoniometer aber auch. In diesem Zusammenhang sei auch die Bemerkung auf S. 248 erwähnt, dass die Laue Methode ihre erste Stelle für die Strukturbestimmung an Drehkristall- usw.-Methoden abtreten musste (das war schon etwa 1927).

Die Beschreibung von Kristallstrukturen (40 Seiten), Defekten (7 Seiten) und Mischkristallen (11 Seiten) gibt eine sehr gute Übersicht. So auch die technischen Abschnitte über Linienverbreiterung (14 Seiten) und Texturbestim-