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Zinc sulphide needles containing new polytypes.

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Two ZnS needles containing eleven new polytypes were found. One needle contains the new polytypes 18*L* (5 4 4 5), 18*L* (7 5 2 4), 54*R* $(5\ 5\ 5\ 3)_3$, 54*R* $(6\ 5\ 3\ 4)_3$ and 54*R* $(7\ 5\ 3\ 3)_3$ of the family 18*L*. The second needle contains the new polytypes 14*L* (4 3 3 4), 42*R* $(8\ 6)_3$, 42*R* $(11\ 3)_3$, 42*R* $(5\ 4\ 3\ 2)_3$ and 42*R* $(6\ 4\ 2\ 2)_3$ of the family 14*L*. X-ray oscillation photographs are shown. The observed and calculated intensities are compared.

Most of the ZnS polytypes hitherto reported were found in platelets, whereas the structure of ZnS needles investigated so far has been found to be mainly pure hexagonal, or hexagonal with stacking faults (Hauptmanová & Pátek, 1963; Mardix, 1966). During our work on polytypism in ZnS needles, we found polytypes of the families 14*L* and 18*L* in two needles. Some of the polytypes found have not been reported so far. They are listed in Table 1.

Table 1. *List of polytypes found*

Specimen	New polytypes found	Other polytypes found
241/52	18*L* (5 4 4 5)	
	18*L* (6 5 3 4)	
	18*L* (7 5 2 4)	
	54*R* $(5\ 5\ 5\ 3)_3$	
	54*R* $(7\ 3\ 6\ 2)_3$	
	54*R* $(7\ 5\ 3\ 3)_3$	
193/53	14*L* (4 3 3 4)	14*L* (5 4 2 3)*
	42*R* $(8\ 6)_3$	42*R* $(12\ 2)_3$†
	42*R* $(11\ 3)_3$	42*R* $(9\ 5)_3$‡
	42*R* $(5\ 4\ 3\ 2)_3$	
	42*R* $(6\ 4\ 2\ 2)_3$	

* Reported earlier (Brafman, Alexander & Steinberger, 1967).

† Reported earlier (Kiflawi, Mardix & Steinberger, 1969).

‡ Reflexion spots of a very narrow region of this polytype are seen in Fig. 1 (6). A larger region was already found in another crystal and will be reported.

The needles were grown by sublimation at 1200°C from pure ZnS powder. The width of specimen 241/52 is ~0·25 mm and of specimen 193/53 ~0·15 mm. Both needles have a large hole along the *c* axis. The width of the polytype regions photographed is between ~0·1 mm and 0·3 mm. Cu *K* radiation, generated by a Hilger & Watts X-ray microfocus generator, was used. The (10.*l*) row lines of the 15° oscillation photographs of the new polytypes are shown in Fig. 1.

The method of identification of the new polytypes is similar to the method described previously (Mardix, Alexander, Brafman & Steinberger, 1967), except for the auxiliary birefringence measurement, which determines the length of the Zhdanov sequence. The birefringence measurement was not feasible, because of the peculiar shape of the needles. Thus, for the first region identified in a specimen, a larger number of Zhdanov sequences had to be taken into account than in a similar case for platelets. The identification of the other polytypes of the same specimen is much simpler, because the length of the Zhdanov sequence could be ascertained by comparing the optical retardation in the polytype to be identified with the retardation in the first polytype.

Observed and calculated intensity distributions of the new polytypes are given in Table 2.

Table 2. *Comparison of observed and calculated intensities of the new polytypes*

Polytypes found in specimen 193/53

l	Obs.		Calc.
14*L* (4 3 3 4)§			
0	*w*	(0 > 1)	5·24
1	*w*		3·62
2	*m*		16·71
3	*s*		47·64
4	*s*		41·01
5	*vvs*		100·00
6	*m*		12·95
7	*s*		43·25

§ The observed intensities are symmetrical with respect to the zero line (*l*=0).

l	Obs.		Calc.
42*R* $(8\ 6)_3$			
1	*vw*		0·775
4	*w*	(4 > −5)	4·69
7	*a*		0·00
10	*s*		18·85
13	*vs*		53·54
16	*vs*		42·55
19	*m*		7·61
−2	*w*	(−2 > −8)	2·61
−5	*w*	(−5 > −2)	3·39
−8	*w*		1·86
−11	*s*	(−11 ~ −17)	32·03
−14	*vvs*		100·00
−17	*s*	(−17 > 10)	29·96
−20	*w*	(−20 ~ −8)	1·77
42*R* $(11\ 3)_3$			
1	*vvw*		0·108
4	*w*		1·60
7	*m*		4·12
10	*m*		6·41
13	*m*	(13 > 19)	7·45
16	*m*	(16 ≈ 13 ≈ 10)	6·93
19	*m*	(19 > 7)	5·34
−2	*vw*		0·425
−5	*w*	(−5 > 4)	2·38
−8	*m*	(−8 ≈ 7)	4·97
−11	*m*	(−11 > −8)	6·93
−14	*vvs*		100·00
−17	*m*	(−17 ≈ −11)	6·48
−20	*m*		4·72

Table 2 (*cont.*)

42*R* (5 4 3 2)$_3$			
1	*w*		3·10
4	*w*	(4 > 1)	5·15
7	*s*	(7 ∼ 16)	32·55
10	*w*	(10 > 4)	6·61
13	*vs*	(13 ∼ −17)	64·96
16	*s*	(16 > 19)	32·05
19	*s*		20·03
−2	*m*		10·46
−5	*w*		3·70
−8	*vvw*		0·748
−11	*vvs*		100·00
−14	*vs*		41·33
−17	*vs*	(−17 > −14)	56·43
−20	*s*		27·72
42*R* (6 4 2 2)$_3$			
1	*w*		6·96
4	*w*	(4 > 1)	9·58
7	*a*		0·00
10	*vs*		58·88
13	*vs*	(13 ≈ 10)	59·07
16	*m*		11·80
19	*vs*	(19 ≈ 10)	53·82
−2	*m*	(−2 > −20)	18·45
−5	*vvw*		0·940
−8	*vw*		2·05
−11	*vvs*		100·00
−14	*vs*	(−14 > −17)	70·64
−17	*vs*	(−17 > 13)	61·17
−20	*m*	(−20 > 16)	15·88

Polytypes found in the specimen 241/52

l	Obs.		Calc.
18*L* (5 4 4 5)*			
0	*m*	(0 > 3)	10·91
1	*w*		4·04
2	*vw*		1·23
3	*m*		9·28
4	*s*		28·82
5	*vs*		86·55
6	*s*		33·33
7	*vvs*		100·00
8	*w*	(8 > 1)	7·56
9	*m*	(9 > 0)	16·18

* The observed intensities are symmetrical with respect to the zero line ($l=0$).

18*L* (6 5 3 4)			
0	*a*		0·00
1	*w*		4·44
2	*w*	(2 > 1)	5·21
3	*w*	(3 > 2)	6·15
4	*m*		14·77
5	*vs*		55·63
6	*s*		33·33
7	*vs*	(7 > 5)	63·19
8	*vw*		3·88
9	*w*		6·13
−1	*w*		5·34
−2	*vvw*		1·47
−3	*w*		6·15
−4	*s*		34·67
−5	*w*		6·31
−6	*vvs*		100·00
−7	*w*		5·97
−8	*s*		32·14
−9	*w*		6·13

Table 2 (*cont.*)

18*L* (7 5 2 4)			
0	*w*		8·56
1	*vw*	(1 > 8)	4·53
2	*w*		7·97
3	*w*		7·28
4	*m*		9·62
5	*vs*		61·92
6	*vs*		56·96
7	*vs*		67·86
8	*vw*		2·53
9	*vvw*		1·81
−1	*vvw*	(−1 > −2)	1·49
−2	*vvw*		0·272
−3	*w*		7·28
−4	*w*		6·40
−5	*vvs*		100·00
−6	*s*		30·69
−7	*s*		31·84
−8	*s*	(−8 > −7)	49·16
−9	*vvw*	(−9 ∼ −1)	1·18
54*R* (7 3 6 2)$_3$			
1	*vw*		1·62
4	*w*		4·39
7	*w*	(7 > 22)	5·08
10	*m*		7·67
13	*s*		12·22
16	*m*		6·94
19	*s*	(19 > 13)	16·30
22	*w*		3·48
25	*m*		14·71
−2	*vvw*		0·789
−5	*w*	(−5 ∼ 22)	3·47
−8	*w*		2·87
−11	*w*	(−11 ≈ −5 > −8)	3·37
−14	*s*		23·87
−17	*vvs*		100·00
−20	*s*		23·79
−23	*vs*		31·88
−26	*vvw*		0·950
54*R* (7 5 3 3)$_3$			
1	*w*		2·86
4	*w*	(4 ≈ 1)	2·35
7	*w*	(7 > 4)	4·61
10	*s*		21·43
13	*m*		11·01
16	*s*		37·59
19	*vs*		65·81
22	*w*		1·96
25	*s*		26·57
−2	*vvw*		0·206
−5	*vw*		0·547
−8	*m*	(−8 > −11)	16·91
−11	*m*	(−11 > −14)	13·71
−14	*m*	(−14 > −26)	8·44
−17	*vvs*		100·00
−20	*vs*		45·83
−23	*s*		20·06
−26	*m*		6·33
54*R* (5 5 5 3)$_3$			
1	*w*		4·38
4	*a*		0·094
7	*w*		4·78
10	*s*		22·24
13	*vvw*		0·876
16	*vs*	(16 > 22)	77·09
19	*w*		4·78

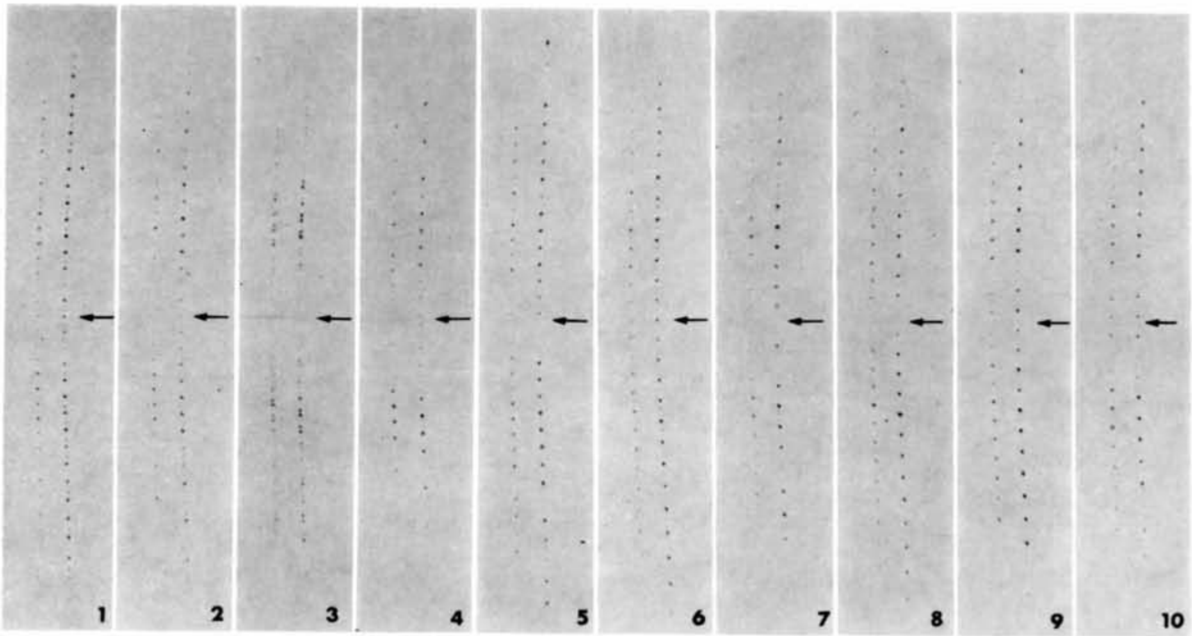

Fig. 1. (10.l) row lines of oscillation photographs about the c axis of the new polytypes. Cu K radiation, 60 mm diameter camera. Magnification $\times 2{\cdot}5$. The zero line indicated by arrow.

No.	Polytypes
1	$18L$ (5 4 4 5) & $54R$ $(5\ 5\ 5\ 3)_3$
2	$18L$ (6 5 3 4)
3	$18L$ (7 5 2 4) & $54R$ $(7\ 5\ 3\ 3)_3$
4	$54R$ $(7\ 3\ 6\ 2)_3$
5	$54R$ $(7\ 5\ 3\ 3)_3$
6	$14L$ (4 3 3 4) & $42R$ $(9\ 5)_3$
7	$42R$ $(8\ 6)_3$ and spots of other polytypes from adjacent regions
8	$42R$ $(11\ 3)_3$
9	$42R$ $(5\ 4\ 3\ 2)_3$
10	$42R$ $(6\ 4\ 2\ 2)_3$

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Table 2 (*cont.*)

22	*vs*		58·28
25	*a*		0·019
−2	*vw*		2·13
−5	*w*		5·37
−8	*a*		0·004
−11	*s*		29·72
−14	*w*		7·11
−17	*vvs*		100·00
−20	*s*	(−20 > −23)	40·17
−23	*s*		29·24
−26	*m*		10·73

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New double polytype region in a zinc sulphide needle. By I. Kiflawi and S. Mardix, *Department of Physics, The Hebrew University, Jerusalem, Israel*

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Eleven new polytypes were found in a zinc sulphide needle. Two of them, 24*L* (6 5 3 5 3 2) and 72*R* (6 5 3 3 5 2)$_3$ were contained in a double polytype region.

The concept of a double polytype region was introduced in a previous publication (Mardix, Kiflawi & Kalman 1969). It is a region of uniform birefringence containing a great number of narrow domains belonging to two different polytypes. The formation of this kind of region was explained by a periodic slip process (Mardix, Kalman & Steinberger, 1968) propagating with the same periodicity in both directions of the *c* axis. The components of the three double polytype regions previously reported were rhombohedral polytypes, whilst the double polytype region reported in this work consists of a mixture of two polytypes; one rhombohedral 72*R* (653352)$_3$ and the other hexagonal 24*L* (653532). These polytypes can be formed from the parent polytype 72*R* (653442)$_3$ by a single slip of the 19th layer propagating with a periodicity of 24 in both directions of the *c* axis. The two polytypes have only one pair of successive Zhdanov numbers different in their Zhdanov sequences, in agreement with the properties of this kind of polytype region stated in the above mentioned work.

The needle No. 106/34 investigated in this work was grown from the vapour phase at approximately 1200° C from pure ZnS powder. It contains single polytype regions as well as the double polytype region. The average diameter of the needle is 0·25 mm and it has a large hole along its *c* axis. A list of the polytypes found is given in Table 1. Eleven of them are new polytypes. Observed and calculated intensity distributions of the new polytypes are compared in Table 2. Their X-ray oscillation photographs are shown in Fig. 1. The procedure of identification is similar to that decribed elsewhere (Mardix, Alexander, Brafman & Steinberger, 1967).

Table 1. *Polytypes found in specimen* 106/34

Region	New polytypes found	Other polytypes found
a	72*R* (6 5 3 3 5 2)$_3$ / 24*L* (6 5 3 5 3 2)	
b	72*R* (6 3 5 6 2 2)$_3$	
c	24*L* (2 2 6 2 2 2 6 2 2)	
d	72*R* (10 7 3 4)$_3$	
e	72*R* (11 5 5 3)$_3$	
f, *g*, *h*	72*R* (7 3 5 2 5 2)$_3$	
i	72*R* (9 3 5 3 2 2)$_3$	
j	72*R* (14 5 2 3)$_3$	
k	24*L* (21 3)	
l	72*R* (14 5 3 2)$_3$	
m		24*L* (7 5 5 7)*

* Previously reported (Mardix, Brafman & Steinberger, 1967).

Table 2. *Comparison of the observed and calculated intensities of the new polytypes*

l	Obs.		Calc.
72*R* (6 5 3 3 5 2)$_3$			
1	*vw*		2·56
4	*vw*		2·43
7	*vvw*		0·190
10	*w*		5·37
13	*m*	(13 > 34)	12·41
16	*w*		5·21
19	*m*		17·30
22	*vvs*		100·00
25	*vw*		2·70
28	*s*	(28 > 31)	34·54
31	*s*		27·62
34	*m*		9·62
−2	*vvw*		0·977
−5	*w*		4·72
−8	*vw*		2·35
−11	*m*		10·50
−14	*m*	(−14 ~ −11)	12·67
−17	*m*		13·05
−20	*vw*	(−20 > −8)	3·45
−23	*vs*		52·31
−26	*s*		22·07
−29	*vw*		2·45
−32	*s*		25·20
−35	*vw*		2·44