Acta Crystallographica Section E
Structure Reports
Online
ISSN 1600-5368

Strontium magnesium borate, $Sr_2Mg(BO_3)_2$

Guo-Jun Chen, Yi-Cheng Wu* and Pei-Zhen Fu

Technical Institute of Physics and Chemistry, Beijing Center for Crystal R&D, Chinese Academy of Sciences, PO Box 2711, Beijing 100080, People's Republic of China
Correspondence e-mail: ycwu@cl.cryo.ac.cn

Received 28 June 2007; accepted 29 July 2007

Key indicators: single-crystal X-ray study; T = 113 K; mean σ(O–B) = 0.024 Å; R factor = 0.065; wR factor = 0.153; data-to-parameter ratio = 9.7.

The title compound contains layers built up from isolated BO_3 triangles and MgO_6 octahedra, interleaved with SrO_9 polyhedra to form a three-dimensional framework. The Sr atom is nine-coordinate in a distorted tricapped trigonal prismatic geometry. Sr, B and one O atom have m point symmetry and Mg $2/m$ point symmetry.

Related literature

For related literature, see: Akella & Keszler (1995); Diaz & Keszler (1997); Verstegen (1974).

Experimental

Crystal data

$Sr_2Mg(BO_3)_2$
M_r = 317.17
Monoclinic, $C2/m$
a = 9.046 (4) Å
b = 5.1579 (18) Å
c = 6.103 (3) Å
β = 118.691 (12)°
V = 249.81 (19) Å^3
Z = 2
Mo $K\alpha$ radiation
μ = 21.44 mm^{-1}
T = 113 (2) K
0.34 × 0.22 × 0.20 mm

Data collection

Rigaku Saturn diffractometer
Absorption correction: numerical (*NUMABS*; Rigaku, 2005) T_{min} = 0.052, T_{max} = 0.100
1180 measured reflections
329 independent reflections
239 reflections with $I > 2\sigma(I)$
R_{int} = 0.124

Refinement

$R[F^2 > 2\sigma(F^2)]$ = 0.065
$wR(F^2)$ = 0.153
S = 1.14
329 reflections
34 parameters
6 restraints
$\Delta\rho_{max}$ = 1.93 e Å^{-3}
$\Delta\rho_{min}$ = −2.76 e Å^{-3}

Table 1
Selected bond lengths (Å).

Sr1—O1^{i}	2.585 (8)	Mg1—O1^{ii}	2.067 (8)
Sr1—O1^{ii}	2.649 (8)	Mg1—O2^{v}	2.145 (12)
Sr1—O1^{iii}	2.654 (9)	O1—B1	1.411 (14)
Sr1—O2^{iv}	2.716 (4)	O2—B1	1.34 (2)
Sr1—O2	2.730 (13)		

Symmetry codes: (i) $-x, -y, -z+1$; (ii) $-x+\frac{1}{2}, y+\frac{1}{2}, -z+1$; (iii) $x+\frac{1}{2}, y+\frac{1}{2}, z+1$; (iv) $-x+\frac{1}{2}, -y+\frac{1}{2}, -z+1$; (v) $-x+1, -y, -z+1$.

Data collection: *CrystalClear* (Rigaku, 2005); cell refinement: *CrystalClear*; data reduction: *CrystalClear*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 1997); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997); molecular graphics: *DIAMOND* (Brandenburg, 1999); software used to prepare material for publication: *CrystalStructure* (Rigaku/MSC, 2004).

This work was supported by the National Natural Science Foundation of China (grant No. 50590402).

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: MG2030).

References

Akella, A. & Keszler, D. A. (1995). *Main Group Met. Chem.* **18**, 35–41.
Brandenburg, K. (1999). *DIAMOND*. Release 2.1c. Crystal Impact GbR, Bonn, Germany.
Diaz, A. & Keszler, D. A. (1997). *Chem. Mater.* **9**, 2071–2077.
Rigaku (2005). *CrystalClear* (Version 1.3.6) and *NUMABS*. Rigaku Corporation, Tokyo, Japan.
Rigaku/MSC (2004). *CrystalStructure*. Version 3.7.0. Rigaku/MSC, The Woodlands, Texas, USA.
Sheldrick, G. M. (1997). *SHELXS97* and *SHELXL97*. University of Göttingen, Germany.
Verstegen, J. M. P. J. (1974). *J. Electrochem. Soc.* **121**, 1631–1633.

 doi:10.1107/S1600536807037099

supplementary materials

Acta Cryst. (2007). E**63**, i175 [**doi:10.1107/S1600536807037099**]

Strontium magnesium borate, $Sr_2Mg(BO_3)_2$

G.-J. Chen, Y.-C. Wu and P.-Z. Fu

Comment

$Sr_2Mg(BO_3)_2$ has been examined as a luminescent host material (Verstegen, 1974; Diaz & Keszler, 1997). Although Diaz & Keszler (1997) alluded to its structure determination and provided cell parameters (a = 9.035 Å, b = 5.146 Å, c = 6.099 Å, β = 118.59°), a full structure report had not appeared to date, to our knowledge. The structure determined here confirms that it is isostructural to $Ba_2Mg(BO_3)_2$, which has been previously described in detail (Akella & Keszler, 1995). Briefly, MgO_6 octahedra and BO_3 triangles are connected to form calcite-like layers which are alternately stacked with double layers of Sr atoms (Fig. 1). Each Sr atom is nine-coordinate, in a distorted tricapped trigonal prismatic geometry.

Experimental

A mixture of 0.3 mol $SrCO_3$, 0.6 mol MgO, 0.6 mol, H_3BO_3, 0.1 mol SrF_2, and 0.7 mol LiF was heated until molten. A Pt thread was dipped into the melt, and the temperature was decreased from 1173 K to 1123 K at 5 K/day, during which time crystals grew on the Pt thread. Upon cooling to room temperature at 20 K/h, block-shaped colourless crystals with dimensions up to 25×15×13 mm^3 were obtained. The crystal used for the data collection was a fragment of the larger crystal.

Refinement

The maximum peak and deepest hole are located 1.40 Å and 1.23 Å, respectively, from Sr.

Figures

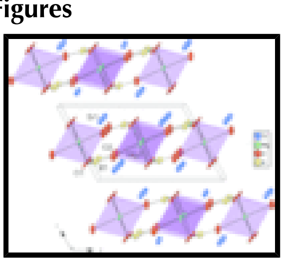

Fig. 1. $Sr_2Mg(BO_3)_2$ viewed down the [010] direction. Displacement ellipsoids are drawn at the 80% probability level.

Distrontium magnesium diborate

Crystal data

$Sr_2Mg(BO_3)_2$	F_{000} = 292
M_r = 317.17	D_x = 4.217 Mg m^{-3}
Monoclinic, *C*2/*m*	Mo *K*α radiation λ = 0.71070 Å
Hall symbol: -C 2y	Cell parameters from 345 reflections

$a = 9.046$ (4) Å	$\theta = 3.8–29.8$°
$b = 5.1579$ (18) Å	$\mu = 21.44$ mm^{-1}
$c = 6.103$ (3) Å	$T = 113$ (2) K
$\beta = 118.691$ (12)°	Prism, colourless
$V = 249.81$ (19) Å^3	0.34 × 0.22 × 0.20 mm
$Z = 2$	

Data collection

Rigaku Saturn diffractometer	329 independent reflections
Radiation source: rotating anode	239 reflections with $I > 2\sigma(I)$
Monochromator: confocal	$R_{int} = 0.124$
$T = 113(2)$ K	$\theta_{max} = 27.9$°
ω scans	$\theta_{min} = 3.8$°
Absorption correction: numerical (NUMABS; Rigaku, 2005)	$h = -11\rightarrow 11$
$T_{min} = 0.052$, $T_{max} = 0.100$	$k = -6\rightarrow 6$
1180 measured reflections	$l = -8\rightarrow 8$

Refinement

Refinement on F^2	Primary atom site location: structure-invariant direct methods
Least-squares matrix: full	Secondary atom site location: difference Fourier map
$R[F^2 > 2\sigma(F^2)] = 0.065$	$w = 1/[\sigma^2(F_o^2) + (0.0588P)^2]$ where $P = (F_o^2 + 2F_c^2)/3$
$wR(F^2) = 0.153$	$(\Delta/\sigma)_{max} < 0.001$
$S = 1.14$	$\Delta\rho_{max} = 1.93$ e Å^{-3}
329 reflections	$\Delta\rho_{min} = -2.76$ e Å^{-3}
34 parameters	Extinction correction: SHELXL97, $Fc^*=kFc[1+0.001xFc^2\lambda^3/\sin(2\theta)]^{-1/4}$
6 restraints	Extinction coefficient: 0.015 (3)

Special details

Geometry. All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s involving l.s. planes.

Refinement. Refinement of F^2 against ALL reflections. The weighted *R*-factor *wR* and goodness of fit S are based on F^2, conventional *R*-factors *R* are based on F, with F set to zero for negative F^2. The threshold expression of $F^2 > 2\mathrm{sigma}(F^2)$ is used only for calculating *R*-factors(gt) *etc*. and is not relevant to the choice of reflections for refinement. *R*-factors based on F^2 are statistically about twice as large as those based on F, and R– factors based on ALL data will be even larger.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å^2)

	x	y	z	U_{iso}*/U_{eq}
Sr1	0.2895 (2)	0.0000	0.8170 (3)	0.0101 (9)
Mg1	0.5000	0.0000	0.5000	0.0100 (19)
O1	−0.0227 (11)	−0.2346 (16)	0.2319 (14)	0.013 (2)
O2	0.2305 (15)	0.0000	0.334 (2)	0.014 (3)
B1	0.065 (3)	0.0000	0.262 (4)	0.015 (5)

Atomic displacement parameters (Å^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Sr1	0.0114 (11)	0.0111 (13)	0.0122 (11)	0.000	0.0092 (8)	0.000
Mg1	0.008 (5)	0.013 (5)	0.014 (4)	0.000	0.009 (4)	0.000
O1	0.017 (5)	0.016 (5)	0.016 (4)	0.004 (4)	0.015 (4)	0.001 (4)
O2	0.012 (7)	0.009 (8)	0.025 (7)	0.000	0.012 (6)	0.000
B1	0.015 (13)	0.018 (14)	0.014 (11)	0.000	0.009 (10)	0.000

Geometric parameters (Å, °)

Sr1—O1^{i}	2.585 (8)	Mg1—Sr1^{x}	3.302 (2)
Sr1—O1^{ii}	2.585 (8)	Mg1—Sr1^{viii}	3.5196 (16)
Sr1—O1^{iii}	2.649 (8)	Mg1—Sr1^{xi}	3.5197 (16)
Sr1—O1^{iv}	2.649 (8)	Mg1—Sr1^{vii}	3.5197 (16)
Sr1—O1^{v}	2.654 (9)	Mg1—Sr1^{iv}	3.5197 (16)
Sr1—O1^{vi}	2.654 (8)	O1—B1	1.411 (14)
Sr1—O2^{vii}	2.716 (4)	O1—Mg1^{xii}	2.067 (8)
Sr1—O2^{iv}	2.716 (4)	O1—Sr1^{i}	2.585 (8)
Sr1—O2	2.730 (13)	O1—Sr1^{iv}	2.649 (8)
Sr1—B1	3.00 (2)	O1—Sr1^{xiii}	2.654 (8)
Sr1—B1^{i}	3.01 (2)	O2—B1	1.34 (2)
Sr1—B1^{vii}	3.036 (12)	O2—Sr1^{vii}	2.716 (4)
Mg1—O1^{iii}	2.067 (8)	O2—Sr1^{iv}	2.716 (4)
Mg1—O1^{viii}	2.067 (8)	B1—O1^{xiv}	1.411 (14)
Mg1—O1^{iv}	2.067 (8)	B1—Sr1^{i}	3.01 (2)
Mg1—O1^{ix}	2.067 (8)	B1—Sr1^{vii}	3.036 (12)
Mg1—O2^{x}	2.145 (12)	B1—Sr1^{iv}	3.036 (12)
Mg1—O2	2.145 (12)		
O1^{i}—Sr1—O1^{ii}	55.8 (4)	O1^{iii}—Mg1—Sr1	53.3 (2)
O1^{i}—Sr1—O1^{iii}	119.65 (7)	O1^{viii}—Mg1—Sr1	126.7 (2)
O1^{ii}—Sr1—O1^{iii}	168.1 (3)	O1^{iv}—Mg1—Sr1	53.3 (2)
O1^{i}—Sr1—O1^{iv}	168.1 (3)	O1^{ix}—Mg1—Sr1	126.7 (2)
O1^{ii}—Sr1—O1^{iv}	119.65 (7)	O2^{x}—Mg1—Sr1	124.6 (4)

$O1^{iii}$—Sr1—$O1^{iv}$	62.2 (4)
$O1^{i}$—Sr1—$O1^{v}$	90.2 (3)
$O1^{ii}$—Sr1—$O1^{v}$	119.07 (18)
$O1^{iii}$—Sr1—$O1^{v}$	70.2 (3)
$O1^{iv}$—Sr1—$O1^{v}$	101.2 (2)
$O1^{i}$—Sr1—$O1^{vi}$	119.07 (18)
$O1^{ii}$—Sr1—$O1^{vi}$	90.2 (3)
$O1^{iii}$—Sr1—$O1^{vi}$	101.2 (2)
$O1^{iv}$—Sr1—$O1^{vi}$	70.2 (3)
$O1^{v}$—Sr1—$O1^{vi}$	62.1 (4)
$O1^{i}$—Sr1—$O2^{vii}$	67.1 (3)
$O1^{ii}$—Sr1—$O2^{vii}$	119.9 (3)
$O1^{iii}$—Sr1—$O2^{vii}$	53.0 (3)
$O1^{iv}$—Sr1—$O2^{vii}$	112.3 (3)
$O1^{v}$—Sr1—$O2^{vii}$	75.1 (3)
$O1^{vi}$—Sr1—$O2^{vii}$	136.2 (3)
$O1^{i}$—Sr1—$O2^{iv}$	119.9 (3)
$O1^{ii}$—Sr1—$O2^{iv}$	67.1 (3)
$O1^{iii}$—Sr1—$O2^{iv}$	112.3 (3)
$O1^{iv}$—Sr1—$O2^{iv}$	53.0 (3)
$O1^{v}$—Sr1—$O2^{iv}$	136.2 (3)
$O1^{vi}$—Sr1—$O2^{iv}$	75.1 (3)
$O2^{vii}$—Sr1—$O2^{iv}$	143.5 (5)
$O1^{i}$—Sr1—O2	100.8 (3)
$O1^{ii}$—Sr1—O2	100.8 (3)
$O1^{iii}$—Sr1—O2	68.4 (3)
$O1^{iv}$—Sr1—O2	68.4 (3)
$O1^{v}$—Sr1—O2	137.2 (3)
$O1^{vi}$—Sr1—O2	137.2 (3)
$O2^{vii}$—Sr1—O2	71.7 (3)
$O2^{iv}$—Sr1—O2	71.7 (3)
$O1^{i}$—Sr1—B1	77.4 (4)
$O1^{ii}$—Sr1—B1	77.4 (4)
$O1^{iii}$—Sr1—B1	90.9 (4)
$O1^{iv}$—Sr1—B1	90.9 (4)
$O1^{v}$—Sr1—B1	148.65 (19)
$O1^{vi}$—Sr1—B1	148.65 (19)
$O2^{vii}$—Sr1—B1	73.6 (3)
$O2^{iv}$—Sr1—B1	73.6 (3)
O2—Sr1—B1	26.5 (5)
$O1^{i}$—Sr1—$B1^{i}$	27.94 (19)
O2—Mg1—Sr1	55.4 (4)
$Sr1^{x}$—Mg1—Sr1	180.0
$O1^{iii}$—Mg1—$Sr1^{viii}$	46.7 (2)
$O1^{viii}$—Mg1—$Sr1^{viii}$	73.4 (2)
$O1^{iv}$—Mg1—$Sr1^{viii}$	106.6 (2)
$O1^{ix}$—Mg1—$Sr1^{viii}$	133.3 (2)
$O2^{x}$—Mg1—$Sr1^{viii}$	50.46 (11)
O2—Mg1—$Sr1^{viii}$	129.54 (11)
$Sr1^{x}$—Mg1—$Sr1^{viii}$	80.56 (5)
Sr1—Mg1—$Sr1^{viii}$	99.44 (5)
$O1^{iii}$—Mg1—$Sr1^{xi}$	106.6 (2)
$O1^{viii}$—Mg1—$Sr1^{xi}$	133.3 (2)
$O1^{iv}$—Mg1—$Sr1^{xi}$	46.7 (2)
$O1^{ix}$—Mg1—$Sr1^{xi}$	73.4 (2)
$O2^{x}$—Mg1—$Sr1^{xi}$	50.46 (11)
O2—Mg1—$Sr1^{xi}$	129.54 (11)
$Sr1^{x}$—Mg1—$Sr1^{xi}$	80.56 (5)
Sr1—Mg1—$Sr1^{xi}$	99.44 (5)
$Sr1^{viii}$—Mg1—$Sr1^{xi}$	94.23 (5)
$O1^{iii}$—Mg1—$Sr1^{vii}$	73.4 (2)
$O1^{viii}$—Mg1—$Sr1^{vii}$	46.7 (2)
$O1^{iv}$—Mg1—$Sr1^{vii}$	133.3 (2)
$O1^{ix}$—Mg1—$Sr1^{vii}$	106.6 (2)
$O2^{x}$—Mg1—$Sr1^{vii}$	129.55 (11)
O2—Mg1—$Sr1^{vii}$	50.46 (11)
$Sr1^{x}$—Mg1—$Sr1^{vii}$	99.44 (5)
Sr1—Mg1—$Sr1^{vii}$	80.56 (5)
$Sr1^{viii}$—Mg1—$Sr1^{vii}$	85.77 (5)
$Sr1^{xi}$—Mg1—$Sr1^{vii}$	180.0
$O1^{iii}$—Mg1—$Sr1^{iv}$	133.3 (2)
$O1^{viii}$—Mg1—$Sr1^{iv}$	106.6 (2)
$O1^{iv}$—Mg1—$Sr1^{iv}$	73.4 (2)
$O1^{ix}$—Mg1—$Sr1^{iv}$	46.7 (2)
$O2^{x}$—Mg1—$Sr1^{iv}$	129.54 (11)
O2—Mg1—$Sr1^{iv}$	50.46 (11)
$Sr1^{x}$—Mg1—$Sr1^{iv}$	99.44 (5)
Sr1—Mg1—$Sr1^{iv}$	80.56 (5)
$Sr1^{viii}$—Mg1—$Sr1^{iv}$	180.0
$Sr1^{xi}$—Mg1—$Sr1^{iv}$	85.77 (5)
$Sr1^{vii}$—Mg1—$Sr1^{iv}$	94.23 (5)
B1—O1—$Mg1^{xii}$	128.9 (10)

O1^{ii}—Sr1—B1^{i}	27.94 (19)	B1—O1—Sr1^{i}	92.9 (9)
O1^{iii}—Sr1—B1^{i}	145.9 (2)	Mg1^{xii}—O1—Sr1^{i}	97.7 (3)
O1^{iv}—Sr1—B1^{i}	145.9 (2)	B1—O1—Sr1^{iv}	91.6 (9)
O1^{v}—Sr1—B1^{i}	107.4 (4)	Mg1^{xii}—O1—Sr1^{iv}	88.0 (3)
O1^{vi}—Sr1—B1^{i}	107.4 (4)	Sr1^{i}—O1—Sr1^{iv}	168.1 (3)
O2^{vii}—Sr1—B1^{i}	93.1 (3)	B1—O1—Sr1^{xiii}	129.1 (10)
O2^{iv}—Sr1—B1^{i}	93.1 (3)	Mg1^{xii}—O1—Sr1^{xiii}	100.9 (3)
O2—Sr1—B1^{i}	100.7 (5)	Sr1^{i}—O1—Sr1^{xiii}	89.8 (3)
B1—Sr1—B1^{i}	74.2 (7)	Sr1^{iv}—O1—Sr1^{xiii}	78.8 (2)
O1^{i}—Sr1—B1^{vii}	92.0 (4)	B1—O2—Mg1	172.3 (13)
O1^{ii}—Sr1—B1^{vii}	146.1 (4)	B1—O2—Sr1^{vii}	90.4 (4)
O1^{iii}—Sr1—B1^{vii}	27.7 (4)	Mg1—O2—Sr1^{vii}	92.0 (3)
O1^{iv}—Sr1—B1^{vii}	89.6 (4)	B1—O2—Sr1^{iv}	90.4 (4)
O1^{v}—Sr1—B1^{vii}	65.6 (4)	Mg1—O2—Sr1^{iv}	92.0 (3)
O1^{vi}—Sr1—B1^{vii}	117.6 (5)	Sr1^{vii}—O2—Sr1^{iv}	143.5 (5)
O2^{vii}—Sr1—B1^{vii}	26.2 (4)	B1—O2—Sr1	87.9 (11)
O2^{iv}—Sr1—B1^{vii}	135.7 (4)	Mg1—O2—Sr1	84.4 (4)
O2—Sr1—B1^{vii}	72.7 (4)	Sr1^{vii}—O2—Sr1	108.3 (3)
B1—Sr1—B1^{vii}	86.0 (5)	Sr1^{iv}—O2—Sr1	108.3 (3)
B1^{i}—Sr1—B1^{vii}	118.9 (4)	O2—B1—O1^{xiv}	120.9 (9)
O1^{iii}—Mg1—O1^{viii}	97.0 (4)	O2—B1—O1	120.9 (9)
O1^{iii}—Mg1—O1^{iv}	83.0 (4)	O1^{xiv}—B1—O1	118.0 (17)
O1^{viii}—Mg1—O1^{iv}	179.998 (1)	O2—B1—Sr1	65.6 (10)
O1^{iii}—Mg1—O1^{ix}	180.0	O1^{xiv}—B1—Sr1	100.5 (9)
O1^{viii}—Mg1—O1^{ix}	83.0 (4)	O1—B1—Sr1	100.5 (9)
O1^{iv}—Mg1—O1^{ix}	97.0 (4)	O2—B1—Sr1^{i}	171.4 (14)
O1^{iii}—Mg1—O2^{x}	88.2 (4)	O1^{xiv}—B1—Sr1^{i}	59.1 (9)
O1^{viii}—Mg1—O2^{x}	91.8 (4)	O1—B1—Sr1^{i}	59.1 (9)
O1^{iv}—Mg1—O2^{x}	88.2 (4)	Sr1—B1—Sr1^{i}	105.8 (7)
O1^{ix}—Mg1—O2^{x}	91.8 (4)	O2—B1—Sr1^{vii}	63.4 (5)
O1^{iii}—Mg1—O2	91.8 (4)	O1^{xiv}—B1—Sr1^{vii}	60.7 (6)
O1^{viii}—Mg1—O2	88.2 (4)	O1—B1—Sr1^{vii}	165.3 (13)
O1^{iv}—Mg1—O2	91.8 (4)	Sr1—B1—Sr1^{vii}	94.0 (5)
O1^{ix}—Mg1—O2	88.2 (4)	Sr1^{i}—B1—Sr1^{vii}	118.9 (4)
O2^{x}—Mg1—O2	180.0	O2—B1—Sr1^{iv}	63.4 (5)
O1^{iii}—Mg1—Sr1^{x}	126.7 (2)	O1^{xiv}—B1—Sr1^{iv}	165.3 (13)
O1^{viii}—Mg1—Sr1^{x}	53.3 (2)	O1—B1—Sr1^{iv}	60.7 (6)
O1^{iv}—Mg1—Sr1^{x}	126.7 (2)	Sr1—B1—Sr1^{iv}	94.0 (5)
O1^{ix}—Mg1—Sr1^{x}	53.3 (2)	Sr1^{i}—B1—Sr1^{iv}	118.9 (4)
O2^{x}—Mg1—Sr1^{x}	55.4 (4)	Sr1^{vii}—B1—Sr1^{iv}	116.3 (7)
O2—Mg1—Sr1^{x}	124.6 (4)		

Symmetry codes: (i) $-x, -y, -z+1$; (ii) $-x, y, -z+1$; (iii) $-x+1/2, y+1/2, -z+1$; (iv) $-x+1/2, -y-1/2, -z+1$; (v) $x+1/2, y+1/2, z+1$; (vi) $x+1/2, -y-1/2, z+1$; (vii) $-x+1/2, -y+1/2, -z+1$; (viii) $x+1/2, y+1/2, z$; (ix) $x+1/2, -y-1/2, z$; (x) $-x+1, -y, -z+1$; (xi) $x+1/2, y-1/2, z$; (xii) $x-1/2, y-1/2, z$; (xiii) $x-1/2, y-1/2, z-1$; (xiv) $x, -y, z$.

Fig. 1