

M-type $\text{Gd}_2[\text{Si}_2\text{O}_7]$

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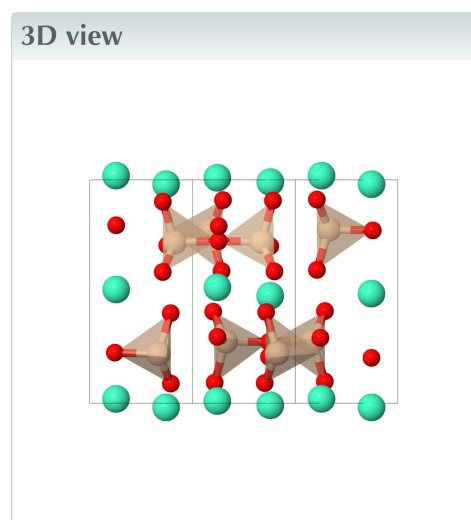
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The title compound, digadolinium(III) oxidodisilicate, $\text{Gd}_2[\text{Si}_2\text{O}_7]$, was obtained in its *M*-type crystal structure after attempts to synthesize $\text{Gd}_5\text{Br}_3[\text{AsO}_3]_4$ as a by-product from fused silica ampoules. It crystallizes isotypically with *M*-type $\text{Eu}_2[\text{Si}_2\text{O}_7]$. This structure consists of layers of ecliptically arranged oxidodisilicate $[\text{Si}_2\text{O}_7]^{6-}$ units separated from each other by bilayers consisting of Gd^{III} cations.



Structure description

M-type $\text{Gd}_2[\text{Si}_2\text{O}_7]$ crystallizes as colourless platelets, isotypic with *M*-type $\text{Eu}_2[\text{Si}_2\text{O}_7]$ (Strobel *et al.*, 2009), in the monoclinic space group $P2_1/n$. In the crystal structure, the two crystallographically distinguishable $[\text{SiO}_4]^{4-}$ tetrahedra form discrete ecliptically arranged oxidodisilicate $[\text{Si}_2\text{O}_7]^{6-}$ units, which stand only on 'two legs', here atoms O1 and O6, like the *E*- (Felsche, 1970) and ζ -type oxidodisilicates (Hartenbach *et al.*, 2006), leading to the so-called 'horseshoe' conformation, with an Si1–O4–Si2 angle of $161.3(3)^\circ$ (Fig. 1). Within the oxidosilicate tetrahedra, Si–O distances (Table 1) ranging from 1.588 (6) to 1.639 (6) Å to the terminal, as well as 1.646 (8) and 1.662 (8) Å to the bridging, oxide ligands (O4) occur, which agree well with those of the well-known dieuropium(III) oxidodisilicate, $\text{Eu}_2[\text{Si}_2\text{O}_7]$, in its *M*-type structure [$d(\text{Si}-\text{O}) = 1.61\text{--}1.66$ Å] (Strobel *et al.*, 2009). Six terminal and four edge-bridging Gd^{III} cations coordinate to each vertex-shared $[\text{Si}_2\text{O}_7]^{6-}$ bitetrahedron, two of which bind one edge each of two terminal O^{2-} anions of one tetrahedral half (O1–O3 and O6–O7) and two of which bind three times each to one terminal O^{2-} anion of both tetrahedral halves of the oxosilicate doubles, as well as to the bridging O atom (O2···O4···O5 and O3···O4···O7). Both crystallographically distinct Gd^{III} cations are surrounded by eight O^{2-} anions, each with Gd–O distances ranging from 2.250 (8) to 2.691 (6) Å (Fig. 2). In the crystal structure of *M*-type $\text{Gd}_2[\text{Si}_2\text{O}_7]$, the $[\text{Si}_2\text{O}_7]^{6-}$ units are present in a layered arrangement parallel to (001) with adjacent bitetrahedra occurring mirrored along [010] at the inversion centre, whereas they are identically oriented along [100]. This structure

Table 1
Selected bond lengths (Å).

Gd1—O1 ⁱ	2.291 (5)	Gd2—O3	2.565 (7)
Gd1—O7 ⁱ	2.305 (8)	Gd2—O4 ^{vii}	2.655 (5)
Gd1—O3 ⁱⁱ	2.376 (8)	Gd2—Si1	3.103 (3)
Gd1—O6	2.384 (5)	Gd2—Si2 ^{vii}	3.233 (3)
Gd1—O5 ⁱⁱⁱ	2.441 (7)	Gd2—Si1 ^{vi}	3.269 (3)
Gd1—O2	2.533 (8)	Gd2—Gd1 ^{viii}	3.8078 (6)
Gd1—O4 ⁱⁱⁱ	2.621 (5)	Si1—O2	1.588 (6)
Gd1—O7 ^{iv}	2.691 (6)	Si1—O1	1.612 (6)
Gd1—Si2 ^{iv}	3.128 (3)	Si1—O3	1.635 (6)
Gd1—Si2 ⁱⁱⁱ	3.217 (3)	Si1—O4 ⁱⁱⁱ	1.646 (8)
Gd1—Si1	3.277 (3)	Si1—Gd2 ^{vi}	3.269 (3)
Gd1—Gd2 ⁱⁱⁱ	3.8078 (6)	Si2—O5	1.595 (6)
Gd2—O5	2.250 (8)	Si2—O6 ^{ix}	1.600 (6)
Gd2—O2 ^v	2.302 (7)	Si2—O7	1.639 (6)
Gd2—O6 ^{vi}	2.313 (5)	Si2—O4	1.662 (8)
Gd2—O7 ^{vii}	2.471 (8)	Si2—Gd1 ^{ix}	3.128 (3)
Gd2—O1	2.472 (5)	Si2—Gd1 ^{viii}	3.217 (3)
Gd2—O3 ^{vi}	2.522 (8)	Si2—Gd2 ^x	3.233 (3)

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

consists of layers of $[\text{Si}_2\text{O}_7]^{6-}$ units separated from each other by bilayers consisting of Gd^{III} cations (Fig. 3).

Synthesis and crystallization

Single crystals of $M\text{-Gd}_2[\text{Si}_2\text{O}_7]$ were obtained as a by-product during the synthesis of $\text{Gd}_5\text{Br}_3[\text{AsO}_3]_4$ (Locke *et al.*, 2023) by

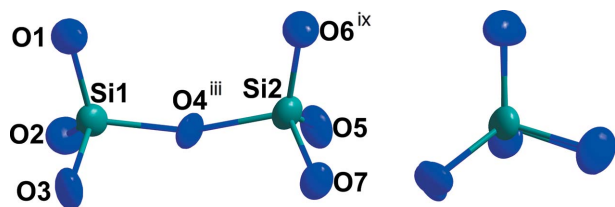


Figure 1
The unique oxidodisilicate $[\text{Si}_2\text{O}_7]^{6-}$ anion composed of two vertex-connected $[\text{SiO}_4]^{4-}$ tetrahedra in M -type $\text{Gd}_2[\text{Si}_2\text{O}_7]$, where the position of the O atoms define a horseshoe arrangement (left), and its Newman projection (right). Displacement ellipsoids are drawn at the 95% probability level. The symmetry codes are available in Table 1.

Table 2
Experimental details.

Crystal data	$\text{Gd}_2[\text{Si}_2\text{O}_7]$
Chemical formula	482.68
M_r	Monoclinic, $P2_1/n$
Crystal system, space group	293
Temperature (K)	7.7267 (5), 8.3859 (6), 9.6814 (7)
a, b, c (Å)	113.486 (3)
β (°)	575.34 (7)
V (Å ³)	4
Z	Mo $K\alpha$
Radiation type	23.25
μ (mm ⁻¹)	1.0 × 0.5 × 0.1
Crystal size (mm)	
Data collection	
Diffractometer	Stoe StadiVari
Absorption correction	Numerical (LANA; Koziskova <i>et al.</i> , 2016)
$T_{\text{min}}, T_{\text{max}}$	0.031, 0.108
No. of measured, independent and observed [$I > 2\sigma(I)$] reflections	11604, 2030, 1462
R_{int}	0.051
$(\sin \theta/\lambda)_{\text{max}}$ (Å ⁻¹)	0.766
Refinement	
$R[F^2 > 2\sigma(F^2)], wR(F^2), S$	0.033, 0.068, 0.95
No. of reflections	2030
No. of parameters	102
$\Delta\rho_{\text{max}}, \Delta\rho_{\text{min}}$ (e Å ⁻³)	1.72, -1.87

Computer programs: *X-AREA* (Stoe & Cie, 2020), *SHELXT* (Sheldrick, 2015a), *SHELXL* (Sheldrick, 2015b), *DIAMOND* (Brandenburg & Putz, 2005) and *publCIF* (Westrip, 2010).

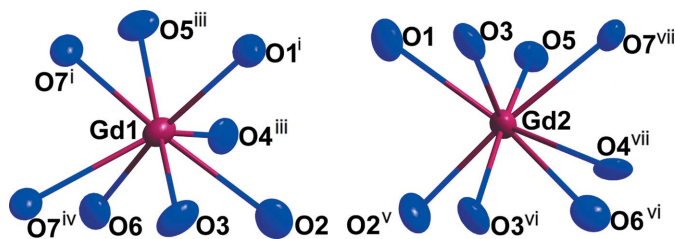


Figure 2
The oxygen environment of the two crystallographically different Gd^{III} cations in M -type $\text{Gd}_2[\text{Si}_2\text{O}_7]$. Displacement ellipsoids are drawn at the 95% probability level. The symmetry codes are available in Table 1.

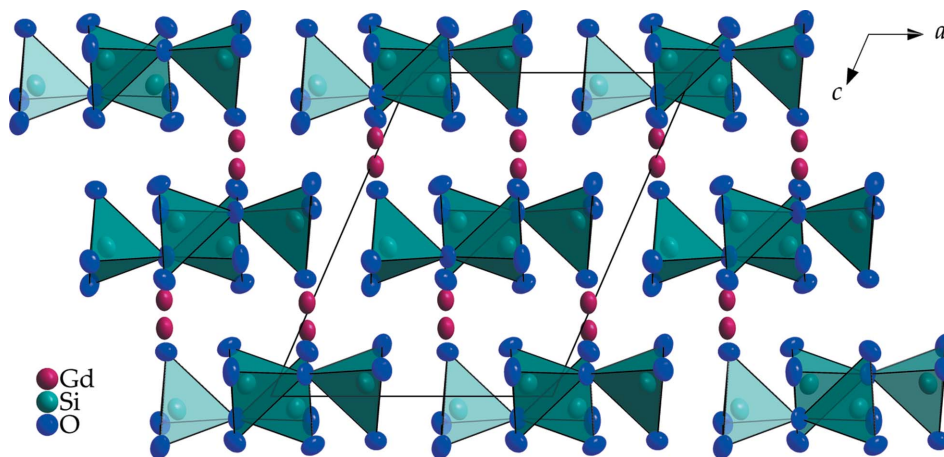


Figure 3
View at the monoclinic crystal structure of M -type $\text{Gd}_2[\text{Si}_2\text{O}_7]$ along $[010]$ emphasizing the discrete $[\text{Si}_2\text{O}_7]^{6-}$ anions (polyhedral representation). Displacement ellipsoids are drawn at the 95% probability level.

reacting Gd_2O_3 with fused silica (SiO_2) as the reaction vessel at a temperature of 1100 K, taking advantage of the presumed mineralizers As_2O_3 and GdBr_3 . The transparent colourless crystals exhibit a platelet-like habit.

Refinement

Crystal data, data collection and structure refinement details are summarized in Table 2.

Acknowledgements

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full crystallographic data

IUCrData (2023). **8**, x230654 [<https://doi.org/10.1107/S2414314623006545>]

M-type Gd₂[Si₂O₇]

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igadolinium(III) oxidodisilicate

Crystal data

Gd₂[Si₂O₇]

$M_r = 482.68$

Monoclinic, $P2_1/n$

$a = 7.7267$ (5) Å

$b = 8.3859$ (6) Å

$c = 9.6814$ (7) Å

$\beta = 113.486$ (3)°

$V = 575.34$ (7) Å³

$Z = 4$

$F(000) = 848$

$D_x = 5.572$ Mg m⁻³

Mo $K\alpha$ radiation, $\lambda = 0.71069$ Å

Cell parameters from 12003 reflections

$\theta = 2.3$ – 33.0 °

$\mu = 23.25$ mm⁻¹

$T = 293$ K

Platelet, colourless

$1.0 \times 0.5 \times 0.1$ mm

Data collection

Stoe StadiVari

diffractometer

Radiation source: fine-focus sealed tube

Detector resolution: 5.81 pixels mm⁻¹

rotation method, ω scans

Absorption correction: numerical

(*LANA*; Koziskova *et al.*, 2016)

$T_{\min} = 0.031$, $T_{\max} = 0.108$

11604 measured reflections

2030 independent reflections

1462 reflections with $I > 2\sigma(I)$

$R_{\text{int}} = 0.051$

$\theta_{\max} = 33.0$ °, $\theta_{\min} = 2.9$ °

$h = -11 \rightarrow 11$

$k = -12 \rightarrow 12$

$l = -14 \rightarrow 14$

Refinement

Refinement on F^2

Least-squares matrix: full

$R[F^2 > 2\sigma(F^2)] = 0.033$

$wR(F^2) = 0.068$

$S = 0.95$

2030 reflections

102 parameters

0 restraints

$w = 1/[\sigma^2(F_o^2) + (0.0305P)^2]$

where $P = (F_o^2 + 2F_c^2)/3$

$(\Delta/\sigma)_{\max} < 0.001$

$\Delta\rho_{\max} = 1.72$ e Å⁻³

$\Delta\rho_{\min} = -1.86$ e Å⁻³

Extinction correction: SHELXL (Sheldrick,

2015b), $F_c^* = kF_c[1 + 0.001 \times F_c^2 \lambda^3 / \sin(2\theta)]^{-1/4}$

Extinction coefficient: 0.0096 (3)

Special details

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

Refinement. Refined as a 2-component twin.

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

	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$
Gd1	0.48343 (8)	0.48090 (4)	0.21037 (4)	0.00929 (12)
Gd2	0.47192 (8)	0.00947 (4)	0.70211 (4)	0.00892 (13)
Si1	0.3936 (4)	0.2763 (3)	0.4626 (3)	0.0091 (6)
Si2	0.3149 (4)	0.2212 (3)	0.9603 (3)	0.0098 (6)
O1	0.4411 (13)	0.2968 (6)	0.6396 (6)	0.0128 (12)
O2	0.2751 (11)	0.4101 (7)	0.3477 (7)	0.0126 (15)
O3	0.3205 (12)	0.0922 (7)	0.4242 (7)	0.0140 (15)
O4	0.0880 (10)	0.2262 (6)	0.9314 (6)	0.0118 (11)
O5	0.3162 (11)	0.0874 (6)	0.8436 (7)	0.0109 (14)
O6	0.4408 (13)	0.2074 (6)	0.1370 (6)	0.0125 (12)
O7	0.3525 (12)	0.4030 (6)	0.9167 (7)	0.0104 (14)

Atomic displacement parameters (\AA^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Gd1	0.0079 (2)	0.0081 (2)	0.0127 (2)	0.0003 (2)	0.0050 (2)	0.00029 (16)
Gd2	0.0078 (2)	0.0078 (2)	0.0120 (2)	-0.0004 (2)	0.0048 (2)	0.00001 (16)
Si1	0.0085 (14)	0.0073 (12)	0.0108 (12)	0.0016 (9)	0.0032 (10)	0.0000 (9)
Si2	0.0102 (14)	0.0087 (13)	0.0120 (12)	-0.0013 (9)	0.0060 (10)	0.0010 (9)
O1	0.014 (4)	0.014 (3)	0.012 (3)	-0.004 (4)	0.007 (4)	-0.001 (2)
O2	0.011 (4)	0.014 (3)	0.010 (3)	0.005 (3)	0.001 (3)	0.002 (2)
O3	0.009 (4)	0.014 (3)	0.021 (4)	-0.003 (3)	0.008 (3)	-0.003 (2)
O4	0.008 (3)	0.011 (3)	0.014 (3)	0.005 (3)	0.005 (3)	0.001 (2)
O5	0.009 (4)	0.009 (3)	0.014 (3)	0.000 (3)	0.004 (3)	-0.005 (2)
O6	0.012 (4)	0.017 (3)	0.009 (3)	0.000 (4)	0.004 (4)	-0.001 (2)
O7	0.012 (4)	0.006 (3)	0.014 (3)	-0.001 (3)	0.007 (3)	-0.001 (2)

Geometric parameters (\AA , $^\circ$)

Gd1—O1 ⁱ	2.291 (5)	Si1—O1	1.612 (6)
Gd1—O7 ⁱ	2.305 (8)	Si1—O3	1.635 (6)
Gd1—O3 ⁱⁱ	2.376 (8)	Si1—O4 ⁱⁱⁱ	1.646 (8)
Gd1—O6	2.384 (5)	Si1—Gd2 ^{vi}	3.269 (3)
Gd1—O5 ⁱⁱⁱ	2.441 (7)	Si2—O5	1.595 (6)
Gd1—O2	2.533 (8)	Si2—O6 ^{ix}	1.600 (6)
Gd1—O4 ⁱⁱⁱ	2.621 (5)	Si2—O7	1.639 (6)
Gd1—O7 ^{iv}	2.691 (6)	Si2—O4	1.662 (8)
Gd1—Si2 ^{iv}	3.128 (3)	Si2—Gd1 ^{ix}	3.128 (3)
Gd1—Si2 ⁱⁱⁱ	3.217 (3)	Si2—Gd1 ^{viii}	3.217 (3)
Gd1—Si1	3.277 (3)	Si2—Gd2 ^x	3.233 (3)
Gd1—Gd2 ⁱⁱⁱ	3.8078 (6)	O1—Gd1 ⁱ	2.291 (5)
Gd2—O5	2.250 (8)	O2—Gd2 ^{xi}	2.302 (7)
Gd2—O2 ^v	2.302 (7)	O3—Gd1 ^{xii}	2.376 (8)
Gd2—O6 ^{vi}	2.313 (5)	O3—Gd2 ^{vi}	2.522 (8)
Gd2—O7 ^{vii}	2.471 (8)	O4—Si1 ^{viii}	1.646 (8)

Gd2—O1	2.472 (5)	O4—Gd1 ^{viii}	2.621 (5)
Gd2—O3 ^{vi}	2.522 (8)	O4—Gd2 ^x	2.655 (5)
Gd2—O3	2.565 (7)	O5—Gd1 ^{viii}	2.441 (7)
Gd2—O4 ^{vii}	2.655 (5)	O6—Si2 ^{iv}	1.600 (6)
Gd2—Si1	3.103 (3)	O6—Gd2 ^{vi}	2.313 (5)
Gd2—Si2 ^{vii}	3.233 (3)	O7—Gd1 ⁱ	2.305 (8)
Gd2—Si1 ^{vi}	3.269 (3)	O7—Gd2 ^x	2.471 (8)
Gd2—Gd1 ^{viii}	3.8078 (6)	O7—Gd1 ^{ix}	2.691 (6)
Si1—O2	1.588 (6)		
O1 ⁱ —Gd1—O7 ⁱ	86.5 (3)	O5—Gd2—Si2 ^{vii}	94.83 (17)
O1 ⁱ —Gd1—O3 ⁱⁱ	88.5 (3)	O2 ^v —Gd2—Si2 ^{vii}	148.23 (16)
O7 ⁱ —Gd1—O3 ⁱⁱ	100.09 (19)	O6 ^{vi} —Gd2—Si2 ^{vii}	72.48 (17)
O1 ⁱ —Gd1—O6	160.3 (2)	O7 ^{vii} —Gd2—Si2 ^{vii}	29.74 (15)
O7 ⁱ —Gd1—O6	106.7 (3)	O1—Gd2—Si2 ^{vii}	128.99 (19)
O3 ⁱⁱ —Gd1—O6	103.0 (3)	O3 ^{vi} —Gd2—Si2 ^{vii}	87.49 (15)
O1 ⁱ —Gd1—O5 ⁱⁱⁱ	84.7 (3)	O3—Gd2—Si2 ^{vii}	75.78 (15)
O7 ⁱ —Gd1—O5 ⁱⁱⁱ	72.1 (2)	O4 ^{vii} —Gd2—Si2 ^{vii}	30.84 (16)
O3 ⁱⁱ —Gd1—O5 ⁱⁱⁱ	170.0 (2)	Si1—Gd2—Si2 ^{vii}	106.49 (7)
O6—Gd1—O5 ⁱⁱⁱ	85.6 (3)	O5—Gd2—Si1 ^{vi}	149.41 (16)
O1 ⁱ —Gd1—O2	85.0 (3)	O2 ^v —Gd2—Si1 ^{vi}	94.01 (18)
O7 ⁱ —Gd1—O2	168.21 (19)	O6 ^{vi} —Gd2—Si1 ^{vi}	71.81 (19)
O3 ⁱⁱ —Gd1—O2	71.6 (2)	O7 ^{vii} —Gd2—Si1 ^{vi}	88.20 (16)
O6—Gd1—O2	83.7 (3)	O1—Gd2—Si1 ^{vi}	127.82 (19)
O5 ⁱⁱⁱ —Gd1—O2	115.06 (16)	O3 ^{vi} —Gd2—Si1 ^{vi}	29.34 (15)
O1 ⁱ —Gd1—O4 ⁱⁱⁱ	95.96 (18)	O3—Gd2—Si1 ^{vi}	77.72 (16)
O7 ⁱ —Gd1—O4 ⁱⁱⁱ	131.3 (2)	O4 ^{vii} —Gd2—Si1 ^{vi}	30.05 (17)
O3 ⁱⁱ —Gd1—O4 ⁱⁱⁱ	128.6 (2)	Si1—Gd2—Si1 ^{vi}	99.74 (6)
O6—Gd1—O4 ⁱⁱⁱ	64.33 (18)	Si2 ^{vii} —Gd2—Si1 ^{vi}	60.26 (5)
O5 ⁱⁱⁱ —Gd1—O4 ⁱⁱⁱ	59.7 (2)	O5—Gd2—Gd1 ^{viii}	37.46 (17)
O2—Gd1—O4 ⁱⁱⁱ	58.0 (2)	O2 ^v —Gd2—Gd1 ^{viii}	139.14 (19)
O1 ⁱ —Gd1—O7 ^{iv}	139.54 (18)	O6 ^{vi} —Gd2—Gd1 ^{viii}	91.6 (3)
O7 ⁱ —Gd1—O7 ^{iv}	66.0 (3)	O7 ^{vii} —Gd2—Gd1 ^{viii}	35.64 (16)
O3 ⁱⁱ —Gd1—O7 ^{iv}	69.1 (3)	O1—Gd2—Gd1 ^{viii}	89.1 (2)
O6—Gd1—O7 ^{iv}	60.18 (17)	O3 ^{vi} —Gd2—Gd1 ^{viii}	147.64 (15)
O5 ⁱⁱⁱ —Gd1—O7 ^{iv}	112.0 (2)	O3—Gd2—Gd1 ^{viii}	88.6 (2)
O2—Gd1—O7 ^{iv}	116.6 (2)	O4 ^{vii} —Gd2—Gd1 ^{viii}	92.70 (16)
O4 ⁱⁱⁱ —Gd1—O7 ^{iv}	124.43 (16)	Si1—Gd2—Gd1 ^{viii}	95.78 (5)
O1 ⁱ —Gd1—Si2 ^{iv}	168.31 (19)	Si2 ^{vii} —Gd2—Gd1 ^{viii}	62.16 (5)
O7 ⁱ —Gd1—Si2 ^{iv}	91.68 (16)	Si1 ^{vi} —Gd2—Gd1 ^{viii}	122.43 (5)
O3 ⁱⁱ —Gd1—Si2 ^{iv}	80.41 (16)	O2—Si1—O1	119.5 (4)
O6—Gd1—Si2 ^{iv}	30.06 (14)	O2—Si1—O3	117.2 (4)
O5 ⁱⁱⁱ —Gd1—Si2 ^{iv}	105.74 (15)	O1—Si1—O3	104.7 (3)
O2—Gd1—Si2 ^{iv}	95.01 (15)	O2—Si1—O4 ⁱⁱⁱ	101.2 (4)
O4 ⁱⁱⁱ —Gd1—Si2 ^{iv}	93.91 (12)	O1—Si1—O4 ⁱⁱⁱ	111.0 (4)
O7 ^{iv} —Gd1—Si2 ^{iv}	31.58 (13)	O3—Si1—O4 ⁱⁱⁱ	101.8 (4)
O1 ⁱ —Gd1—Si2 ⁱⁱⁱ	91.52 (18)	O2—Si1—Gd2	156.8 (3)
O7 ⁱ —Gd1—Si2 ⁱⁱⁱ	100.47 (18)	O1—Si1—Gd2	52.31 (19)

O3 ⁱⁱ —Gd1—Si2 ⁱⁱⁱ	159.41 (19)	O3—Si1—Gd2	55.7 (2)
O6—Gd1—Si2 ⁱⁱⁱ	72.03 (17)	O4 ⁱⁱⁱ —Si1—Gd2	102.0 (2)
O5 ⁱⁱⁱ —Gd1—Si2 ⁱⁱⁱ	28.81 (16)	O2—Si1—Gd2 ^{vi}	112.5 (3)
O2—Gd1—Si2 ⁱⁱⁱ	87.91 (15)	O1—Si1—Gd2 ^{vi}	127.9 (3)
O4 ⁱⁱⁱ —Gd1—Si2 ⁱⁱⁱ	30.98 (17)	O3—Si1—Gd2 ^{vi}	49.1 (3)
O7 ^{iv} —Gd1—Si2 ⁱⁱⁱ	121.22 (15)	O4 ⁱⁱⁱ —Si1—Gd2 ^{vi}	53.89 (19)
Si2 ^{iv} —Gd1—Si2 ⁱⁱⁱ	100.16 (3)	Gd2—Si1—Gd2 ^{vi}	80.26 (6)
O1 ⁱ —Gd1—Si1	91.69 (18)	O2—Si1—Gd1	48.9 (3)
O7 ⁱ —Gd1—Si1	160.70 (18)	O1—Si1—Gd1	135.2 (3)
O3 ⁱⁱ —Gd1—Si1	99.08 (19)	O3—Si1—Gd1	118.8 (3)
O6—Gd1—Si1	70.92 (19)	O4 ⁱⁱⁱ —Si1—Gd1	52.41 (19)
O5 ⁱⁱⁱ —Gd1—Si1	88.55 (16)	Gd2—Si1—Gd1	153.91 (9)
O2—Gd1—Si1	28.19 (15)	Gd2 ^{vi} —Si1—Gd1	79.48 (6)
O4 ⁱⁱⁱ —Gd1—Si1	29.85 (17)	O5—Si2—O6 ^{ix}	122.3 (4)
O7 ^{iv} —Gd1—Si1	123.92 (15)	O5—Si2—O7	114.8 (4)
Si2 ^{iv} —Gd1—Si1	93.76 (7)	O6 ^{ix} —Si2—O7	104.4 (3)
Si2 ⁱⁱⁱ —Gd1—Si1	60.34 (5)	O5—Si2—O4	101.7 (4)
O1 ⁱ —Gd1—Gd2 ⁱⁱⁱ	89.6 (3)	O6 ^{ix} —Si2—O4	109.5 (4)
O7 ⁱ —Gd1—Gd2 ⁱⁱⁱ	38.66 (17)	O7—Si2—O4	102.5 (4)
O3 ⁱⁱ —Gd1—Gd2 ⁱⁱⁱ	138.72 (18)	O5—Si2—Gd1 ^{ix}	156.8 (3)
O6—Gd1—Gd2 ⁱⁱⁱ	92.0 (2)	O6 ^{ix} —Si2—Gd1 ^{ix}	48.29 (18)
O5 ⁱⁱⁱ —Gd1—Gd2 ⁱⁱⁱ	34.10 (16)	O7—Si2—Gd1 ^{ix}	59.3 (2)
O2—Gd1—Gd2 ⁱⁱⁱ	149.15 (15)	O4—Si2—Gd1 ^{ix}	101.5 (2)
O4 ⁱⁱⁱ —Gd1—Gd2 ⁱⁱⁱ	92.60 (17)	O5—Si2—Gd1 ^{viii}	47.5 (3)
O7 ^{iv} —Gd1—Gd2 ⁱⁱⁱ	86.64 (19)	O6 ^{ix} —Si2—Gd1 ^{viii}	136.8 (3)
Si2 ^{iv} —Gd1—Gd2 ⁱⁱⁱ	96.26 (5)	O7—Si2—Gd1 ^{viii}	117.8 (3)
Si2 ⁱⁱⁱ —Gd1—Gd2 ⁱⁱⁱ	61.86 (5)	O4—Si2—Gd1 ^{viii}	54.3 (2)
Si1—Gd1—Gd2 ⁱⁱⁱ	122.19 (5)	Gd1 ^{ix} —Si2—Gd1 ^{viii}	155.51 (9)
O5—Gd2—O2 ^v	101.69 (19)	O5—Si2—Gd2 ^x	112.2 (3)
O5—Gd2—O6 ^{vi}	84.4 (3)	O6 ^{ix} —Si2—Gd2 ^x	125.5 (3)
O2 ^v —Gd2—O6 ^{vi}	82.3 (3)	O7—Si2—Gd2 ^x	48.4 (3)
O5—Gd2—O7 ^{vii}	72.5 (2)	O4—Si2—Gd2 ^x	55.0 (2)
O2 ^v —Gd2—O7 ^{vii}	170.8 (2)	Gd1 ^{ix} —Si2—Gd2 ^x	81.32 (6)
O6 ^{vi} —Gd2—O7 ^{vii}	89.9 (3)	Gd1 ^{viii} —Si2—Gd2 ^x	80.91 (6)
O5—Gd2—O1	81.0 (3)	Si1—O1—Gd1 ⁱ	130.8 (3)
O2 ^v —Gd2—O1	80.8 (2)	Si1—O1—Gd2	96.6 (2)
O6 ^{vi} —Gd2—O1	154.8 (2)	Gd1 ⁱ —O1—Gd2	131.5 (3)
O7 ^{vii} —Gd2—O1	104.9 (3)	Si1—O2—Gd2 ^{xi}	142.9 (5)
O5—Gd2—O3 ^{vi}	172.35 (19)	Si1—O2—Gd1	102.9 (4)
O2 ^v —Gd2—O3 ^{vi}	73.0 (2)	Gd2 ^{xi} —O2—Gd1	108.3 (2)
O6 ^{vi} —Gd2—O3 ^{vi}	89.4 (3)	Si1—O3—Gd1 ^{xii}	132.2 (4)
O7 ^{vii} —Gd2—O3 ^{vi}	112.04 (17)	Si1—O3—Gd2 ^{vi}	101.6 (4)
O1—Gd2—O3 ^{vi}	103.2 (3)	Gd1 ^{xii} —O3—Gd2 ^{vi}	106.4 (2)
O5—Gd2—O3	115.4 (3)	Si1—O3—Gd2	92.6 (3)
O2 ^v —Gd2—O3	119.4 (2)	Gd1 ^{xii} —O3—Gd2	114.0 (3)
O6 ^{vi} —Gd2—O3	143.85 (18)	Gd2 ^{vi} —O3—Gd2	107.8 (3)
O7 ^{vii} —Gd2—O3	69.9 (3)	Si1 ^{viii} —O4—Si2	161.3 (3)
O1—Gd2—O3	61.35 (18)	Si1 ^{viii} —O4—Gd1 ^{viii}	97.7 (3)

O3 ^{vi} —Gd2—O3	72.2 (3)	Si2—O4—Gd1 ^{viii}	94.7 (3)
O5—Gd2—O4 ^{vii}	121.6 (2)	Si1 ^{viii} —O4—Gd2 ^x	96.1 (3)
O2 ^v —Gd2—O4 ^{vii}	119.9 (2)	Si2—O4—Gd2 ^x	94.2 (3)
O6 ^{vi} —Gd2—O4 ^{vii}	64.64 (16)	Gd1 ^{viii} —O4—Gd2 ^x	104.97 (18)
O7 ^{vii} —Gd2—O4 ^{vii}	60.2 (2)	Si2—O5—Gd2	142.3 (4)
O1—Gd2—O4 ^{vii}	140.50 (18)	Si2—O5—Gd1 ^{viii}	103.7 (4)
O3 ^{vi} —Gd2—O4 ^{vii}	58.9 (2)	Gd2—O5—Gd1 ^{viii}	108.4 (2)
O3—Gd2—O4 ^{vii}	79.25 (17)	Si2 ^{iv} —O6—Gd2 ^{vi}	131.8 (3)
O5—Gd2—Si1	104.65 (16)	Si2 ^{iv} —O6—Gd1	101.7 (3)
O2 ^v —Gd2—Si1	95.40 (16)	Gd2 ^{vi} —O6—Gd1	126.0 (2)
O6 ^{vi} —Gd2—Si1	171.0 (2)	Si2—O7—Gd1 ⁱ	136.3 (4)
O7 ^{vii} —Gd2—Si1	93.06 (15)	Si2—O7—Gd2 ^x	101.8 (4)
O1—Gd2—Si1	31.07 (14)	Gd1 ⁱ —O7—Gd2 ^x	105.7 (2)
O3 ^{vi} —Gd2—Si1	81.58 (15)	Si2—O7—Gd1 ^{ix}	89.1 (3)
O3—Gd2—Si1	31.75 (14)	Gd1 ⁱ —O7—Gd1 ^{ix}	114.0 (3)
O4 ^{vii} —Gd2—Si1	109.70 (12)	Gd2 ^x —O7—Gd1 ^{ix}	106.8 (3)

Symmetry codes: (i) $-x+1, -y+1, -z+1$; (ii) $-x+1/2, y+1/2, -z+1/2$; (iii) $x+1/2, -y+1/2, z-1/2$; (iv) $x, y, z-1$; (v) $x+1/2, -y+1/2, z+1/2$; (vi) $-x+1, -y, -z+1$; (vii) $-x+1/2, y-1/2, -z+3/2$; (viii) $x-1/2, -y+1/2, z+1/2$; (ix) $x, y, z+1$; (x) $-x+1/2, y+1/2, -z+3/2$; (xi) $x-1/2, -y+1/2, z-1/2$; (xii) $-x+1/2, y-1/2, -z+1/2$.