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Decacarbonyl(μ-ethylidenimino-1κN:2κC)-μ-hydrido-*triangulo*-triosmium(3 *Os–Os*)

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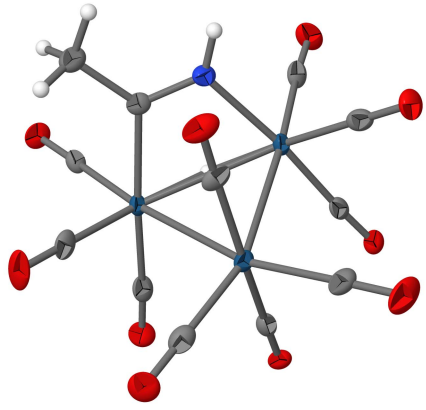
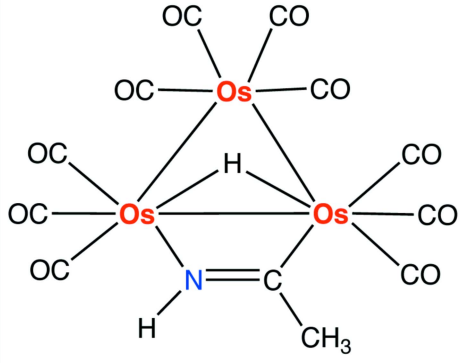
The title complex, $[Os_3(C_2H_4N)H(CO)_{10}]$ or $[Os_3(CO)_{10}(\mu\text{-}H)(\mu\text{-}HN{=}C{-}CH_3\text{-}1\kappa N{:}2\kappa C)]$, was synthesized in 41.6% yield by reactions between $Os_3(CO)_{11}(CH_3CN)$ and 2,4,6-trimethylhexahydro-1,3,5-triazine. The central osmium triangle has two Os^I atoms bridged by a hydride ligand and a μ-HN=C$-$CH$_3$-1κN:2κC triazine fragment. Three CO ligands complete the coordination sphere around each Os^I atom, while the remaining Os^0 atom has four CO ligands. Each Os atom exhibits a pseudo-octahedral coordination environment, discounting the bridging Os$-$Os bond.

3D view



Chemical scheme



Structure description

Previous research (Liu *et al.*, 2003) has shown that 1,3,5-trimethylhexahydro-1,3,5-triazine reacts with Group 8 carbonyl compounds $M_3(CO)_{12}$ (M = Fe and Ru) to form $[(\mu\text{-}H)M_3(CO)_{11}][MeN(MeNCH_2)_2CH]$ anionic hydrido clusters, with the transfer of a hydride from the triazine to the metal carbonyl. While Fe and Ru starting materials reacted with the triazine directly, $Os_3(CO)_{12}$ was first converted to $Os_3(CO)_{11}(CH_3CN)$ to accomplish the same result. Liu and co-workers subsequently reported the products of reactions of $Os_3(CO)_{12}$ with 1,3,5-trimethylhexahydro-1,3,5-triazine, which yielded three products, *i.e.* a trimer containing a μ-N(CH$_3$)$-$CH$_2-$N(CH$_3$) triazine fragment and a hydride bridge, a trimer containing a μ_3-N(CH$_3$)$-$CH$_2-$N(CH$_3$) triazine fragment and a hydride bridge, and a dimer with two bridging N(CH$_3$)$-$CH$-$N(CH$_3$) fragments perpendicular to one another forming a sawhorse-type complex (Liu *et al.*, 2005). In these complexes, each bridge has a N$-$C$-$N backbone. We were interested in further investigating the reactions of $Os_3(CO)_{12}$ and $Os_3(CO)_{11}(CH_3CN)$ with triazines using microwave heating.

We report here the synthesis and structure of the title complex, $Os_3(CO)_{10}(\mu\text{-}H)(\mu\text{-}HN{=}C{-}CH_3\text{-}1\kappa N{:}2\kappa C)$, a trinuclear osmium compound which was the product of

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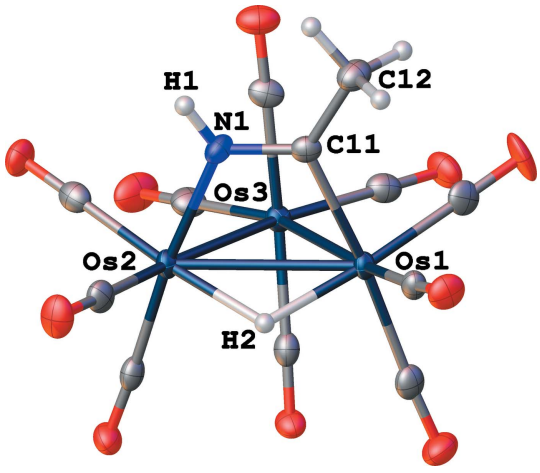

Figure 1
The molecular structure of the title compound, with displacement ellipsoids drawn at the 50% probability level.

reactions between $Os_3(CO)_{11}(CH_3CN)$ and 2,4,6-trimethylhexahydro-1,3,5-triazine. The product yield was 41.6%. Rather than containing a bridge with an N—C—N backbone, $Os_3(CO)_{10}(\mu$-H)(μ-HN═C—CH_3-1κN:2κC) contains a μ-HN═C—CH_3-1κN:2κC triazine fragment bridge with a N—C backbone and a hydride bridge across two Os atoms in the central osmium triangle. A few related trinuclear structures of iron, ruthenium, and osmium with bridging μ-HN═C—R-1κN:2κC species and nine CO ligands have been reported (Andrews *et al.*, 1978; Dawoodi *et al.*, 1981; Takao *et al.*, 2018). The only previously reported trinuclear structure which has ten CO ligands and the same (μ-)κ^2-N,C(H—N═C—R) bridging configuration as the title complex is that for $Os_3(CO)_9PMe_2Ph(\mu$-H)(μ-HN═C—CF_3-1κN:2κC) which was synthesized in 4.3% yield by the reaction of $H_2Os_3(CO)_9PMe_2Ph$ with CF_3CN (Adams *et al.*, 1981).

Table 1
Experimental details.

Crystal data	
Chemical formula	$[Os_3(C_2H_4N)H(CO)_{10}]$
M_r	893.77
Crystal system, space group	Orthorhombic, $P2_12_12_1$
Temperature (K)	100
a, b, c (Å)	9.56470 (6), 11.59555 (8), 15.61610 (11)
V (Å^3)	1731.95 (2)
Z	4
Radiation type	Cu $K\alpha$
μ (mm^{-1})	41.18
Crystal size (mm)	0.15 × 0.07 × 0.02
Data collection	
Diffractometer	Rigaku SuperNova AtlasS2 CCD
Absorption correction	Gaussian (*CrysAlis PRO*; Rigaku OD, 2017)
T_{min}, T_{max}	0.109, 1.000
No. of measured, independent and observed [$I > 2\sigma(I)$] reflections	33313, 3487, 3471
R_{int}	0.052
(sin $\theta/\lambda)_{max}$ (Å^{-1})	0.622
Refinement	
$R[F^2 > 2\sigma(F^2)]$, $wR(F^2)$, S	0.015, 0.037, 1.06
No. of reflections	3487
No. of parameters	241
No. of restraints	2
H-atom treatment	H atoms treated by a mixture of independent and constrained refinement
$\Delta\rho_{max}$, $\Delta\rho_{min}$ (e Å^{-3})	0.58, −0.89
Absolute structure	Refined as an inversion twin.
Absolute structure parameter	0.465 (16)

Computer programs: *CrysAlis PRO* (Rigaku OD, 2017), *SHELXL2018* (Sheldrick, 2015), *OLEX2* (Dolomanov *et al.*, 2009) and *publCIF* (Westrip, 2010).

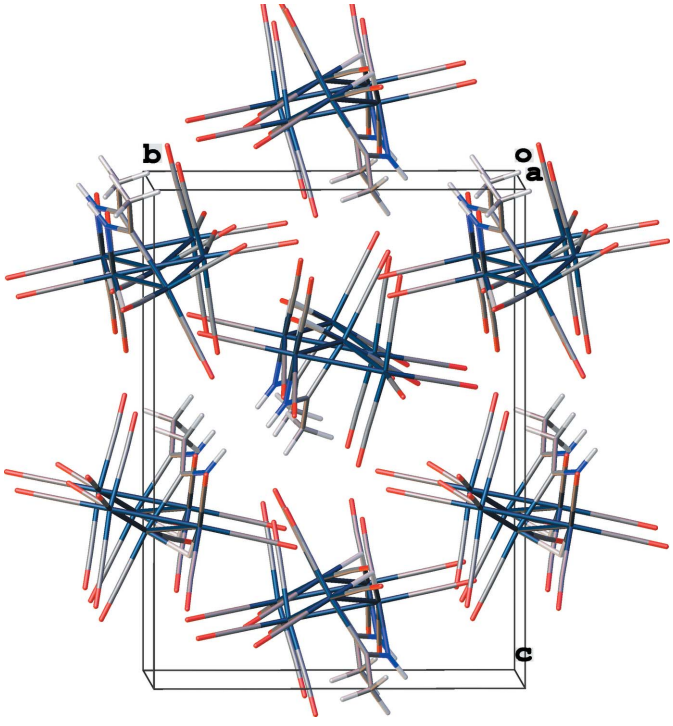

Figure 2
The packing of the molecules of the title compound in a view approximately along the *a* axis.

In the title complex, the bridged Os^I atoms (Os1 and Os2) have three terminal CO ligands in addition to the ethylidenimino and hydride ligands, and the Os^0 atom (Os3) has four terminal CO ligands (Fig. 1). Each of the three Os atoms exhibits a pseudo-octahedral coordination environment, discounting the bridged Os—Os bond. The individual octahedra of each bridged Os atom are rotated on average by 24 (4)° out of the plane of the osmium traingle toward the mid-point of the metal–metal bond. The Os—Os bond length for the bridged bond is 2.9331 (4) Å, while the unbridged Os—Os bond lengths are shorter, as expected, at 2.8604 (4) and 2.8759 (4) Å. The molecules stack so that the planes containing the triangular Os_3 units are roughly perpendicular to the *c* axis (Fig. 2). A 2_1 screw axis passes through the centers of the Os_3 triangles. Thus, every Os_3 unit in the stack is rotated 180° from the one above it and below it so that the triazine fragments of every other molecule are facing in the opposite direction. Although an N—H donor group is present, there is no evidence of classical hydrogen bonding in the crystal.

Synthesis and crystallization

Dodcecacarbonyltriosmium(0) (60.2 mg, 0.066 mmol) and CH_3CN (7.5 ml) were placed in a 35 ml glass reaction vessel, then sealed with a PTFE cap and placed in a CEM Discover-SP microwave reactor. The mixture was stirred and heated at 411 K for 9 min to yield a green solution of $Os_3(CO)_{11}(CH_3CN)$ (Jung *et al.*, 2009). The reaction vessel was removed from the microwave reactor. The solvent was removed by rotary evaporation. 1,2-Dichloroethane (7 ml) was added to the dry $Os_3(CO)_{11}(CH_3CN)$. Acetaldehyde ammonia trimer (61.2 mg, 0.474 mmol) was then added to the vessel, which was then sealed with a PTFE cap, and the mixture was stirred and heated in a microwave reactor at 398 K for 20 min to produce a yellow–orange solution. The solvent was then removed by rotary evaporation, and the residue was dissolved in CH_2Cl_2 and subjected to thin-layer chromatography using an eluent mixture of 2.5:1 (*v*/*v*) hexanes/CH_2Cl_2. Two yellow bands were collected. The top band contained 2.1 mg of an unidentified compound and had an R_F value of 0.82. IR (νCO, $CHCl_3$): 2103 (*w*), 2065 (*vs*), 2050 (*m*), 2034 (*w*), 2017 (*s*), 2001 (*m*), 1988 (*sh*) cm^{-1}. The second band consisted of 24.7 mg of the title complex (41.6% yield) and had an R_F value of 0.67. IR (νCO, *n*-hexane): 2105 (*w*), 2064 (*vs*), 2052 (*s*), 2024 (*s*), 2007 (*vs*), 1991 (*m*), 1977 (*w*) cm^{-1}. ^{1}H NMR (60 MHz, $CDCl_3$): δ 2.18 (*s*, 3H, CH_3), −15.15 (*s*, 1H, Os—H—Os). Crystals were grown at 277 K *via* *p*-xylene vapor diffusion into a $CHCl_3$ solution.

Refinement

Crystal data, data collection and structure refinement details are summarized in Table 1. The crystal under investigation was twinned by inversion; TWIN and BASF commands were used to refine the absolute structure parameter for this noncentrosymmetric structure. The bridging hydride ligand and the N-bound H atom were both located in a difference Fourier map. A DFIX command was used to constrain the position of the hydride H atom, while an AFIX command was used to constrain the N-bound H atom.

Acknowledgements

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Funding information

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References

Adams, R. D., Katahira, D. A. & Yang, L.-W. (1981). *J. Organomet. Chem.* **219**, 85–101.
Andrews, M. A., van Buskirk, G., Knobler, C. B. & Kaesz, H. D. (1978). *J. Am. Chem. Soc.* **101**, 7245–7254.
Dawoodi, Z., Mays, M. & Raithby, P. R. (1981). *J. Organomet. Chem.* **219**, 103–113.
Dolomanov, O. V., Bourhis, L. J., Gildea, R. J., Howard, J. A. K. & Puschmann, H. (2009). *J. Appl. Cryst.* **42**, 339–341.
Jung, J. Y., Newton, B. S., Tonkin, M. L., Powell, C. B. & Powell, G. L. (2009). *J. Organomet. Chem.* **694**, 3526–3528.
Liu, Y.-C., Yeh, W.-Y., Lee, G.-H. & Peng, S.-M. (2003). *Organometallics*, **22**, 4163–4166.
Liu, Y.-C., Yeh, W.-Y., Lee, G.-H. & Peng, S.-M. (2005). *J. Organomet. Chem.* **690**, 163–167.
Rigaku OD (2017). *CrysAlis PRO*. Rigaku Corporation, Tokyo, Japan.
Sheldrick, G. M. (2015). *Acta Cryst.* C**71**, 3–8.
Takao, T., Horikoshi, S., Kawashima, T., Asano, S., Takahashi, Y., Sawano, A. & Suzuki, H. (2018). *Organometallics*, **37**, 1598–1614.
Westrip, S. P. (2010). *J. Appl. Cryst.* **43**, 920–925.

full crystallographic data

IUCrData (2019). **4**, x191386 [https://doi.org/10.1107/S2414314619013865]

Decacarbonyl(*μ*-ethylidenimino-1*κN*:2*κC*)-*μ*-hydrido-*triangulo*-triosmium(3 *Os*–*Os*)

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Decacarbonyl(*μ*-ethylidenimino-1*κN*:2*κC*)-*μ*-hydrido-*triangulo*-triosmium(3 *Os*–*Os*)

Crystal data

$[Os_3(C_2H_4N)H(CO)_{10}]$
M_r = 893.77
Orthorhombic, $P2_12_12_1$
a = 9.56470 (6) Å
b = 11.59555 (8) Å
c = 15.61610 (11) Å
V = 1731.95 (2) Å^3
Z = 4
$F(000)$ = 1568
D_x = 3.428 Mg m^{-3}
Cu $K\alpha$ radiation, λ = 1.54184 Å
Cell parameters from 23076 reflections
θ = 3.8–73.5°
μ = 41.18 mm^{-1}
T = 100 K
Plate, clear reddish orange
0.15 × 0.07 × 0.02 mm

Data collection

Rigaku SuperNova AtlasS2 CCD diffractometer
Radiation source: micro-focus sealed X-ray tube, SuperNova (Cu) X-ray Source
Mirror monochromator
Detector resolution: 5.2387 pixels mm^{-1}
ω scans
Absorption correction: gaussian (*CrysAlis PRO*; Rigaku OD, 2017)
T_{min} = 0.109, T_{max} = 1.000
33313 measured reflections
3487 independent reflections
3471 reflections with $I > 2\sigma(I)$
R_{int} = 0.052
θ_{max} = 73.6°, θ_{min} = 4.8°
h = −11→11
k = −14→14
l = −19→19

Refinement

Refinement on F^2
Least-squares matrix: full
$R[F^2 > 2\sigma(F^2)]$ = 0.015
$wR(F^2)$ = 0.037
S = 1.06
3487 reflections
241 parameters
2 restraints
Hydrogen site location: mixed
H atoms treated by a mixture of independent and constrained refinement
$w = 1/[\sigma^2(F_o^2) + (0.0177P)^2 + 1.930P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max}$ = 0.001
$\Delta\rho_{max}$ = 0.58 e Å^{-3}
$\Delta\rho_{min}$ = −0.89 e Å^{-3}
Absolute structure: Refined as an inversion twin.
Absolute structure parameter: 0.465 (16)

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. An AFIX command was used to constrain the N-bound H atom. A DFIX command was used to constrain the position of hydride H atom.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å²)

	x	*y*	*z*	U_{iso}*/U_{eq}
Os1	0.55519 (3)	0.47729 (2)	0.31968 (2)	0.01492 (7)
Os3	0.81319 (3)	0.37203 (2)	0.37293 (2)	0.01544 (7)
Os2	0.81157 (3)	0.61402 (2)	0.33737 (2)	0.01578 (7)
O8	0.7118 (6)	0.1256 (5)	0.4066 (3)	0.0295 (12)
O2	0.2816 (6)	0.6049 (5)	0.2863 (3)	0.0265 (11)
N1	0.6712 (6)	0.6362 (5)	0.4404 (3)	0.0192 (11)
H1	0.687362	0.682623	0.483836	0.023*
O6	1.0711 (6)	0.6239 (5)	0.4504 (3)	0.0270 (11)
O5	0.7938 (6)	0.8712 (4)	0.2948 (4)	0.0309 (12)
O1	0.5513 (7)	0.3569 (5)	0.1421 (3)	0.0317 (12)
O7	0.8601 (5)	0.3331 (4)	0.1797 (3)	0.0218 (10)
O9	1.1229 (6)	0.3324 (6)	0.4109 (4)	0.0375 (15)
O3	0.4224 (6)	0.2725 (5)	0.4103 (4)	0.0355 (13)
O4	0.9924 (5)	0.5754 (5)	0.1790 (3)	0.0246 (11)
C8	0.7491 (7)	0.2157 (7)	0.3941 (4)	0.0237 (15)
C1	0.5576 (8)	0.4015 (6)	0.2072 (4)	0.0235 (14)
O10	0.7542 (6)	0.4424 (5)	0.5608 (3)	0.0292 (12)
C11	0.5588 (8)	0.5746 (6)	0.4332 (4)	0.0179 (13)
C9	1.0074 (8)	0.3481 (7)	0.3968 (5)	0.0254 (16)
C6	0.9740 (8)	0.6201 (6)	0.4085 (5)	0.0225 (15)
C3	0.4709 (7)	0.3493 (7)	0.3761 (5)	0.0238 (16)
C4	0.9231 (7)	0.5866 (6)	0.2380 (4)	0.0199 (14)
C10	0.7726 (7)	0.4187 (6)	0.4916 (4)	0.0209 (15)
C12	0.4450 (8)	0.5834 (7)	0.4983 (4)	0.0259 (15)
H12A	0.363183	0.620690	0.472632	0.039*
H12B	0.477705	0.629330	0.547069	0.039*
H12C	0.419399	0.506005	0.518069	0.039*
C5	0.7956 (7)	0.7757 (6)	0.3109 (5)	0.0231 (14)
C7	0.8407 (7)	0.3485 (6)	0.2497 (5)	0.0206 (14)
C2	0.3870 (7)	0.5583 (6)	0.2960 (4)	0.0190 (14)
H2	0.652 (9)	0.592 (9)	0.273 (6)	0.09 (5)*

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Os1	0.01033 (13)	0.01544 (13)	0.01901 (13)	−0.00051 (10)	−0.00092 (12)	0.00164 (10)
Os3	0.01224 (14)	0.01589 (12)	0.01820 (13)	0.00247 (12)	0.00051 (11)	0.00095 (10)
Os2	0.01117 (13)	0.01577 (13)	0.02039 (13)	−0.00120 (11)	−0.00046 (11)	0.00136 (10)
O8	0.037 (3)	0.019 (2)	0.033 (3)	−0.003 (2)	0.008 (2)	0.005 (2)
O2	0.021 (3)	0.030 (3)	0.029 (2)	0.009 (2)	−0.007 (2)	0.001 (2)
N1	0.017 (3)	0.021 (3)	0.020 (3)	0.002 (3)	−0.004 (2)	−0.005 (2)
O6	0.016 (2)	0.033 (3)	0.032 (3)	−0.001 (2)	−0.007 (2)	−0.002 (2)

O5	0.031 (3)	0.018 (2)	0.044 (3)	0.000 (2)	−0.007 (2)	0.007 (2)
O1	0.031 (3)	0.039 (3)	0.025 (3)	−0.003 (3)	−0.002 (2)	−0.010 (2)
O7	0.024 (3)	0.020 (2)	0.021 (3)	0.0001 (19)	0.006 (2)	−0.005 (2)
O9	0.019 (3)	0.057 (4)	0.037 (3)	0.015 (3)	−0.005 (2)	−0.006 (3)
O3	0.022 (3)	0.027 (3)	0.057 (4)	−0.007 (2)	0.009 (3)	0.022 (3)
O4	0.020 (2)	0.028 (3)	0.026 (3)	−0.004 (2)	0.005 (2)	−0.003 (2)
C8	0.021 (4)	0.029 (4)	0.021 (3)	0.006 (3)	0.001 (3)	0.001 (3)
C1	0.015 (3)	0.026 (4)	0.029 (3)	0.001 (3)	−0.005 (3)	0.003 (3)
O10	0.035 (3)	0.033 (3)	0.020 (3)	0.013 (2)	0.002 (2)	0.000 (2)
C11	0.020 (3)	0.017 (3)	0.017 (3)	0.004 (3)	−0.002 (3)	0.002 (2)
C9	0.024 (4)	0.030 (4)	0.022 (3)	0.004 (3)	0.006 (3)	−0.003 (3)
C6	0.028 (4)	0.016 (3)	0.024 (3)	0.001 (3)	0.005 (3)	0.000 (3)
C3	0.011 (3)	0.032 (4)	0.029 (3)	0.005 (3)	−0.004 (3)	0.002 (3)
C4	0.014 (3)	0.018 (3)	0.028 (3)	0.000 (3)	−0.006 (3)	−0.001 (3)
C10	0.021 (4)	0.021 (3)	0.021 (4)	0.010 (3)	0.002 (3)	0.003 (3)
C12	0.023 (4)	0.031 (4)	0.024 (3)	0.003 (3)	0.000 (3)	−0.006 (3)
C5	0.014 (3)	0.029 (4)	0.025 (3)	−0.001 (3)	−0.004 (3)	0.003 (3)
C7	0.016 (3)	0.017 (3)	0.029 (4)	−0.001 (2)	−0.001 (3)	0.000 (3)
C2	0.018 (4)	0.019 (3)	0.020 (3)	−0.003 (3)	−0.003 (3)	0.003 (3)

Geometric parameters (Å, º)

Os1—Os3	2.8759 (4)	O8—C8	1.121 (10)
Os1—Os2	2.9331 (4)	O2—C2	1.154 (9)
Os1—C1	1.964 (7)	N1—H1	0.8800
Os1—C11	2.102 (6)	N1—C11	1.296 (10)
Os1—C3	1.904 (8)	O6—C6	1.137 (9)
Os1—C2	1.899 (7)	O5—C5	1.136 (9)
Os1—H2	1.78 (6)	O1—C1	1.142 (9)
Os3—Os2	2.8604 (4)	O7—C7	1.124 (9)
Os3—C8	1.942 (8)	O9—C9	1.142 (10)
Os3—C9	1.914 (8)	O3—C3	1.138 (9)
Os3—C10	1.969 (7)	O4—C4	1.141 (9)
Os3—C7	1.961 (7)	O10—C10	1.128 (9)
Os2—N1	2.111 (6)	C11—C12	1.493 (10)
Os2—C6	1.911 (7)	C12—H12A	0.9800
Os2—C4	1.910 (7)	C12—H12B	0.9800
Os2—C5	1.926 (7)	C12—H12C	0.9800
Os2—H2	1.84 (6)		
Os3—Os1—Os2	58.988 (9)	N1—Os2—Os3	88.56 (16)
Os3—Os1—H2	89 (3)	N1—Os2—H2	85 (4)
Os2—Os1—H2	37 (2)	C6—Os2—Os1	139.0 (2)
C1—Os1—Os3	93.4 (2)	C6—Os2—Os3	85.3 (2)
C1—Os1—Os2	108.4 (2)	C6—Os2—N1	94.0 (3)
C1—Os1—C11	173.9 (3)	C6—Os2—C5	98.8 (3)
C1—Os1—H2	88 (4)	C6—Os2—H2	174 (2)
C11—Os1—Os3	88.3 (2)	C4—Os2—Os1	107.5 (2)

C11—Os1—Os2	67.5 (2)	C4—Os2—Os3	89.5 (2)
C11—Os1—H2	86 (4)	C4—Os2—N1	174.1 (3)
C3—Os1—Os3	84.2 (2)	C4—Os2—C6	91.4 (3)
C3—Os1—Os2	137.0 (2)	C4—Os2—C5	91.8 (3)
C3—Os1—C1	94.0 (3)	C4—Os2—H2	90 (4)
C3—Os1—C11	92.0 (3)	C5—Os2—Os1	116.1 (2)
C3—Os1—H2	173 (2)	C5—Os2—Os3	175.6 (2)
C2—Os1—Os3	173.2 (2)	C5—Os2—N1	89.7 (3)
C2—Os1—Os2	117.3 (2)	C5—Os2—H2	87 (3)
C2—Os1—C1	93.3 (3)	Os2—N1—H1	123.4
C2—Os1—C11	85.0 (3)	C11—N1—Os2	113.3 (4)
C2—Os1—C3	96.7 (3)	C11—N1—H1	123.4
C2—Os1—H2	90 (3)	O8—C8—Os3	179.7 (7)
Os2—Os3—Os1	61.502 (10)	O1—C1—Os1	176.3 (7)
C8—Os3—Os1	100.1 (2)	N1—C11—Os1	112.5 (5)
C8—Os3—Os2	161.3 (2)	N1—C11—C12	120.6 (6)
C8—Os3—C10	92.0 (3)	C12—C11—Os1	126.8 (5)
C8—Os3—C7	94.6 (3)	O9—C9—Os3	179.2 (8)
C9—Os3—Os1	161.8 (2)	O6—C6—Os2	179.6 (7)
C9—Os3—Os2	100.7 (2)	O3—C3—Os1	179.0 (7)
C9—Os3—C8	97.9 (3)	O4—C4—Os2	176.7 (6)
C9—Os3—C10	92.8 (3)	O10—C10—Os3	176.9 (6)
C9—Os3—C7	92.3 (3)	C11—C12—H12A	109.5
C10—Os3—Os1	89.2 (2)	C11—C12—H12B	109.5
C10—Os3—Os2	85.0 (2)	C11—C12—H12C	109.5
C7—Os3—Os1	83.7 (2)	H12A—C12—H12B	109.5
C7—Os3—Os2	86.9 (2)	H12A—C12—H12C	109.5
C7—Os3—C10	171.1 (3)	H12B—C12—H12C	109.5
Os1—Os2—H2	35 (2)	O5—C5—Os2	176.3 (7)
Os3—Os2—Os1	59.509 (9)	O7—C7—Os3	177.8 (6)
Os3—Os2—H2	88 (3)	O2—C2—Os1	175.8 (6)
N1—Os2—Os1	66.78 (15)		
Os2—N1—C11—Os1	−1.3 (6)	Os2—N1—C11—C12	−177.2 (5)