Boroxide, Borsäure

B_2O_3: farblos, glasig (sehr schwer kristallisierbar), hygroskopisch:

$$B_2O_3 + 3H_2O \Rightarrow H_3BO_3 = B(OH)_3$$

Darstellung: $B(OH)_3$ {glühen} $\Rightarrow B_2O_3$

Verwendung: Boratgläser (durch Metalloxide gefärbt),
Borsilicatgläser (Pyrex: geringer Ausdehnungskoeffizient)

niedere Boroxide: BO, B_2O, B_6O, $B_{13}O_2 = B_{12}$–OBO

$B(OH)_3$: schwache einbasige Säure ($pK_S = 9{,}25$):

OH^--Aufnahme statt H^+-Abgabe: $B(OH)_3 + 2H_2O \Leftrightarrow H_3O^+B(OH)_4^-$

Darstellung: $Na_2B_4O_7 \cdot 10H_2O + 2HCl + 5H_2O \Rightarrow 4B(OH)_3 + 2NaCl$

Esterbildung: $B(OH)_3 + 3CH_3OH \Rightarrow 3H_2O + B(OCH_3)_3$

HBO_2: Metaborsäure: $B(OH)_3$ {120°C} $\Rightarrow H_2O + HBO_2$

α-HBO_2 (orthorhombisch): cyclisches Trimer

β-HBO_2 (monoklin): Kettenpolymer

γ-HBO_2 (kubisch): dreidimensional vernetzt

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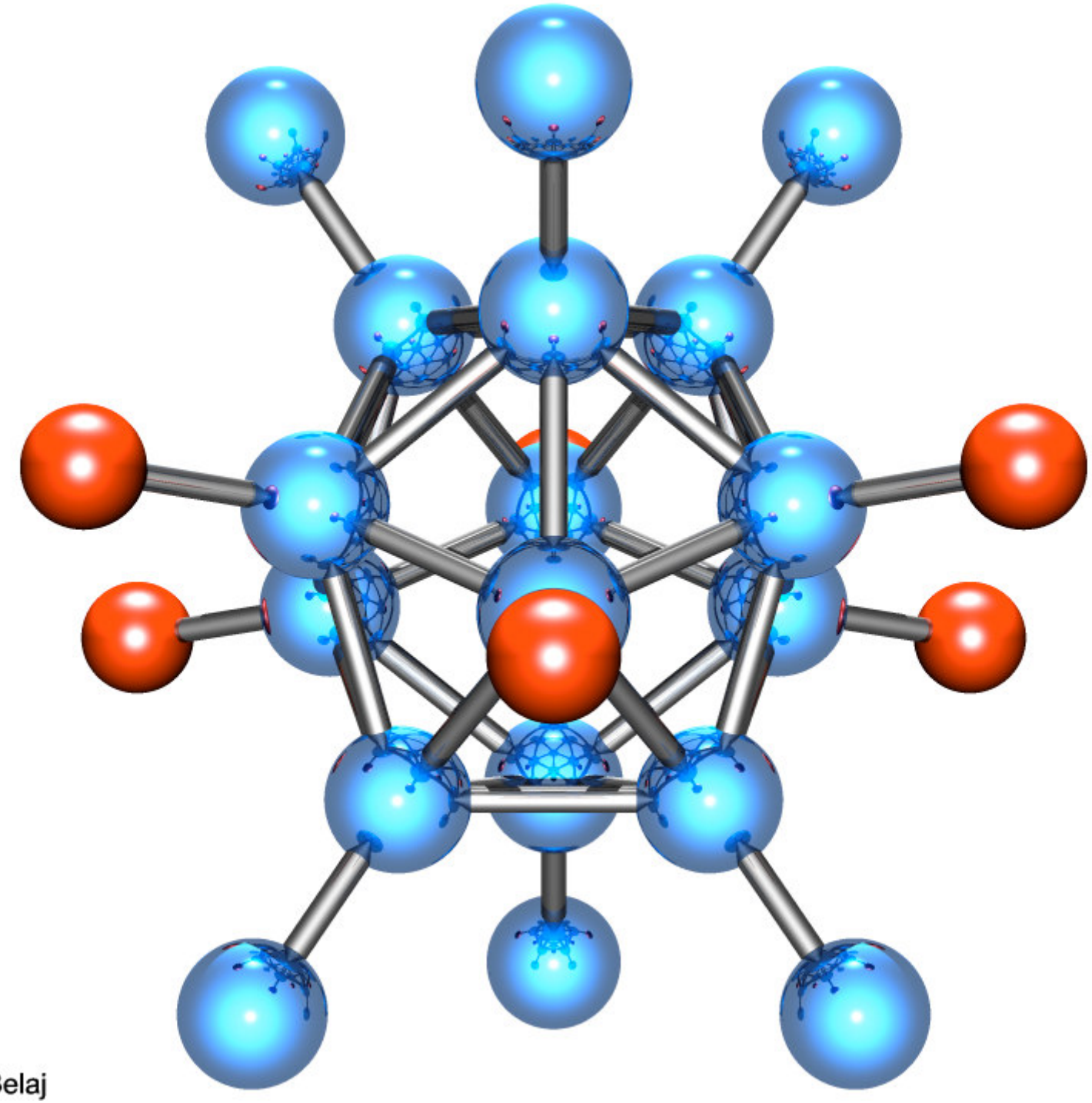
B6O



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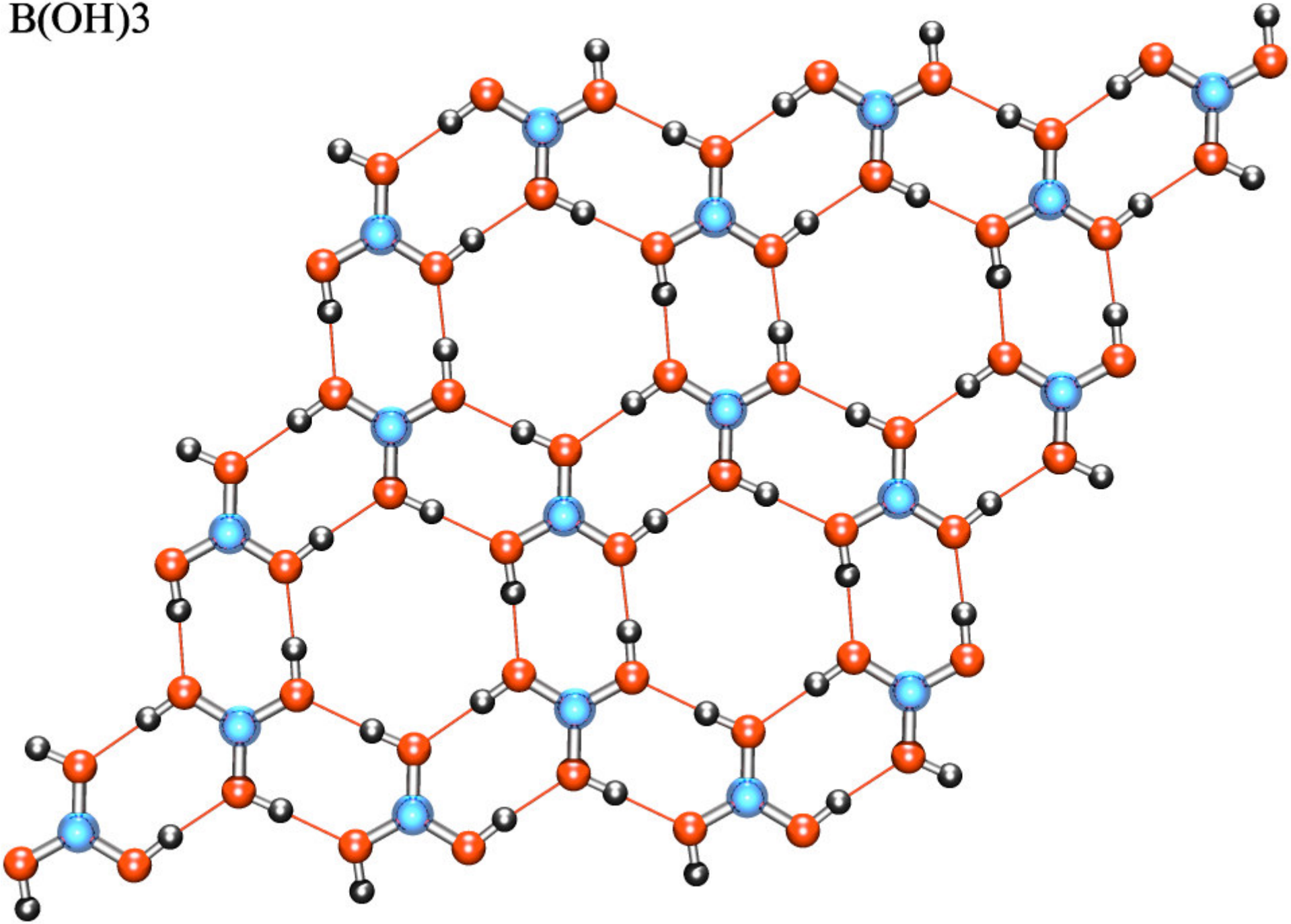
B(OH)3



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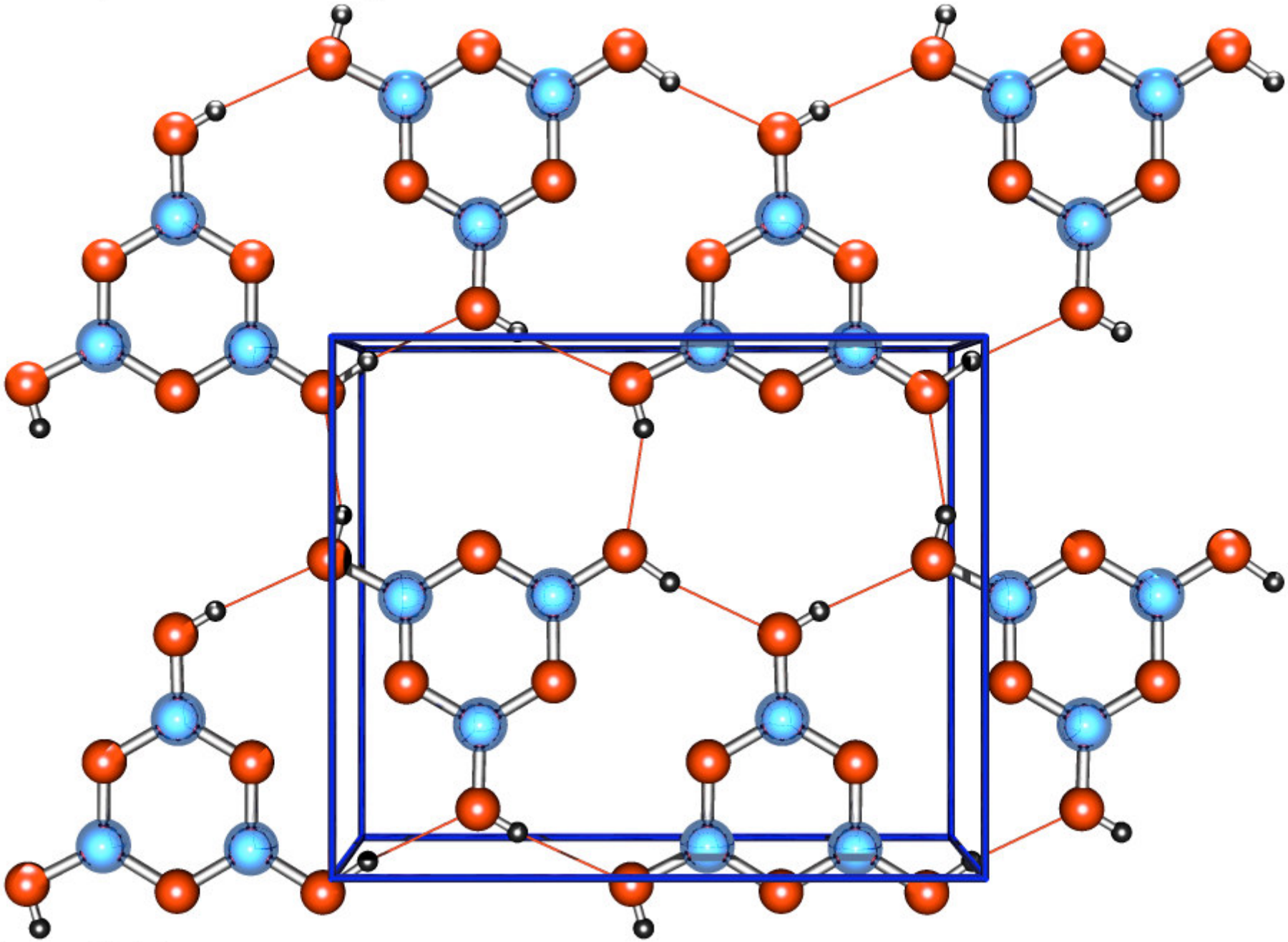
HBO2 (orthorhombic)



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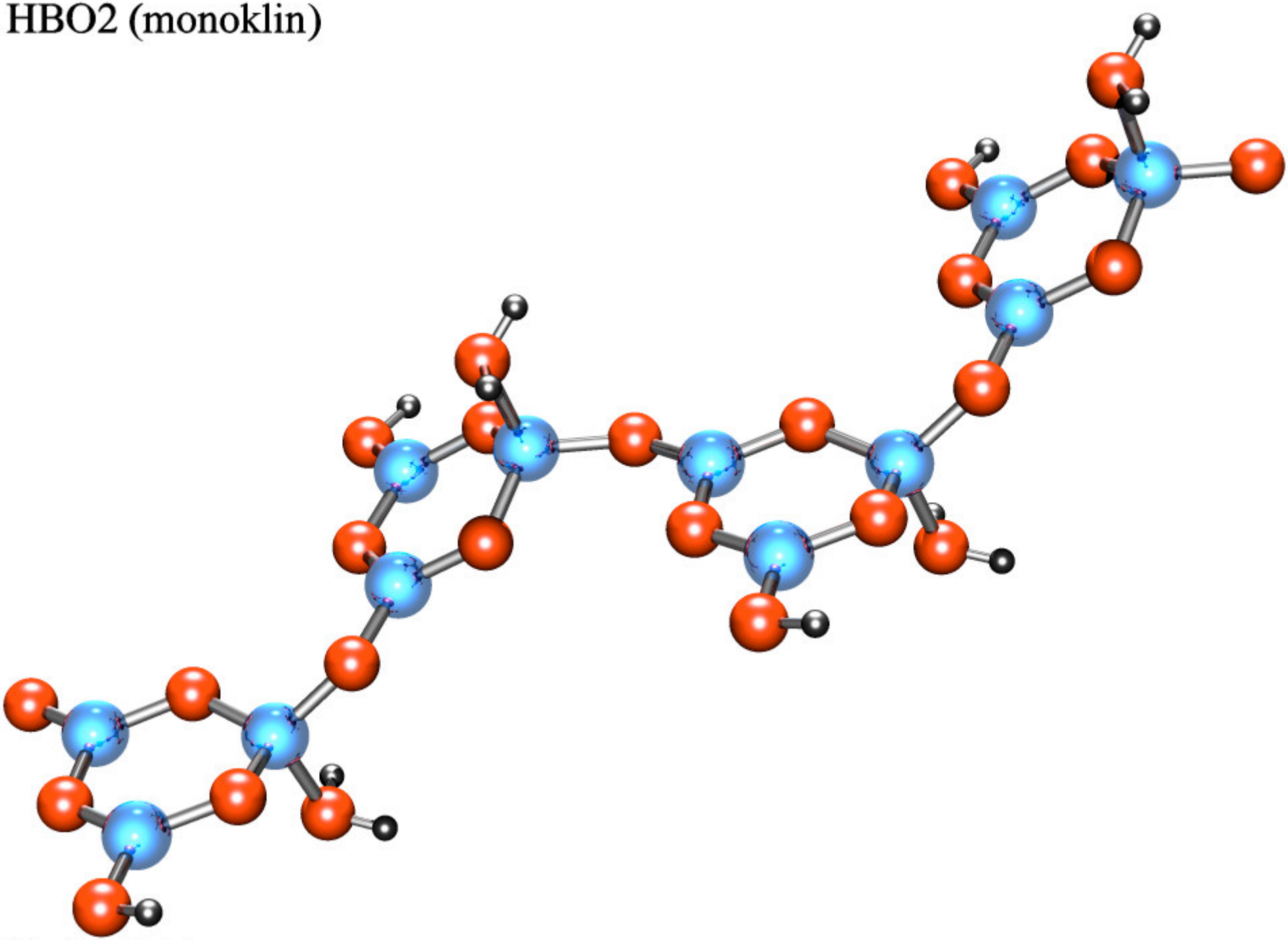
HBO2 (monoklin)



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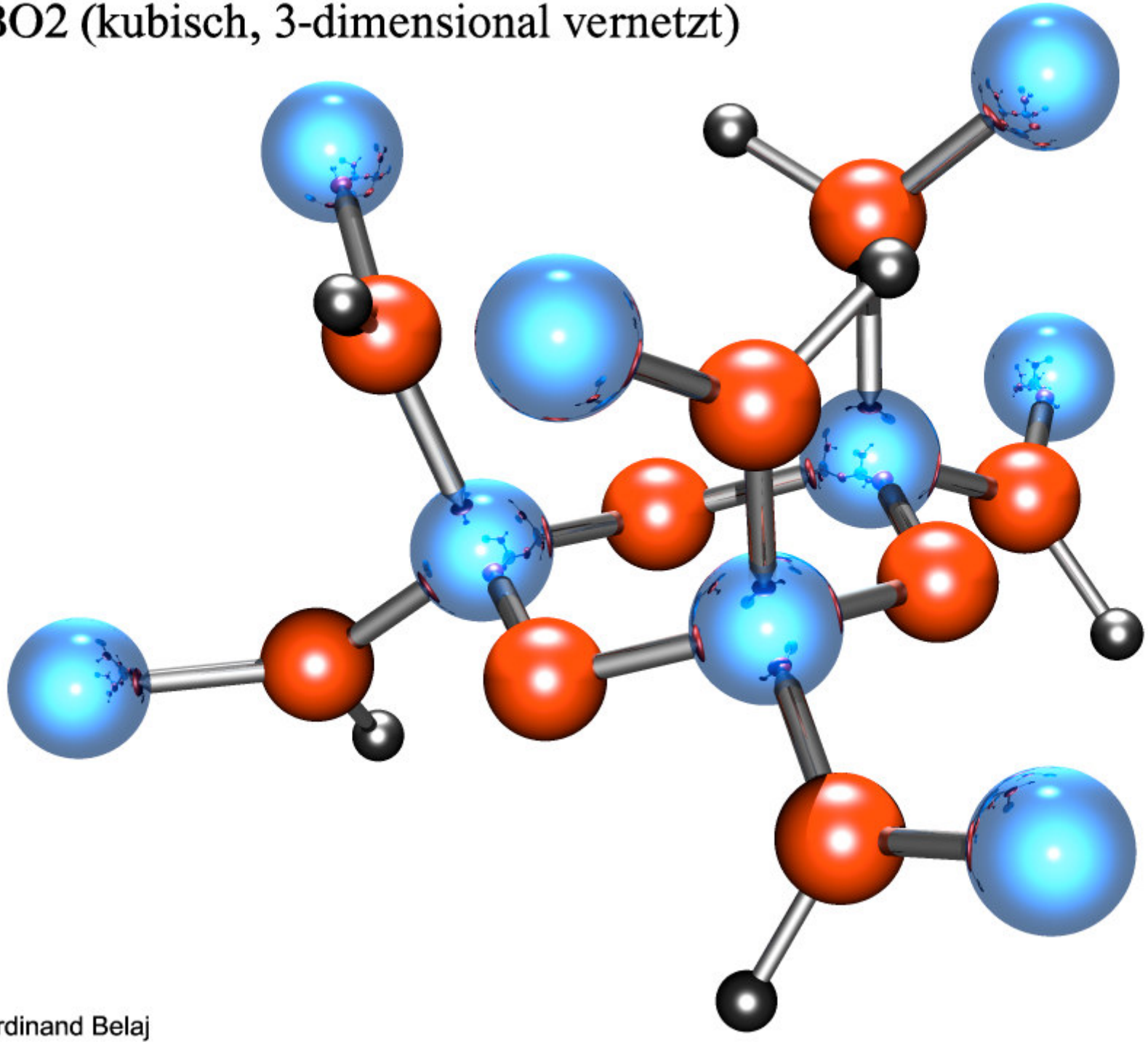
HBO2 (kubisch, 3-dimensional vernetzt)



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Borate

meist hydratisierte Salze der Orthoborsäure $B(OH)_3$, Metaborsäure HBO_2 und deren Oligo- bzw. Polymerisationsprodukten:

a) Monoborate: z.B. $LaBO_3$: trigonal-planares BO_3^{-3}-Ion
$TaBO_4$: tetraedrisches BO_4^{-5}-Ion
$LiB(OH)_4$: tetraedrisches $B(OH)_4^-$-Ion

b) Oligoborate:

Pyroborat (=Diborat) $Mg_2B_2O_5$: planares $B_2O_5^{-4}$-Ion,
$MgB_2O_4 \cdot 3H_2O = MgB_2O(OH)_6$

Triborate: $Ca_2B_6O_{11} \cdot 7H_2O = 2Ca[B_3O_3(OH)_5] \cdot H_2O$

Tetraborate: Borax $Na_2B_4O_7 \cdot 10H_2O = Na_2[B_4O_5(OH)_4] \cdot 8H_2O$:
Bicyclus

Pentaborate: $NaB_5O_8 \cdot 5H_2O = Na[B_5O_6(OH)_4] \cdot 3H_2O$:
Spiro-verbindung

Hexaborate: $MgB_6O_{10} \cdot 5H_2O = Mg[B_6O_7(OH)_6] \cdot 2H_2O$:
Tricyclus

c) Polyborate: Kernit $Na_2B_4O_7 \cdot 4H_2O = Na_2[B_2O_3(OH)]_2 \cdot 3H_2O$

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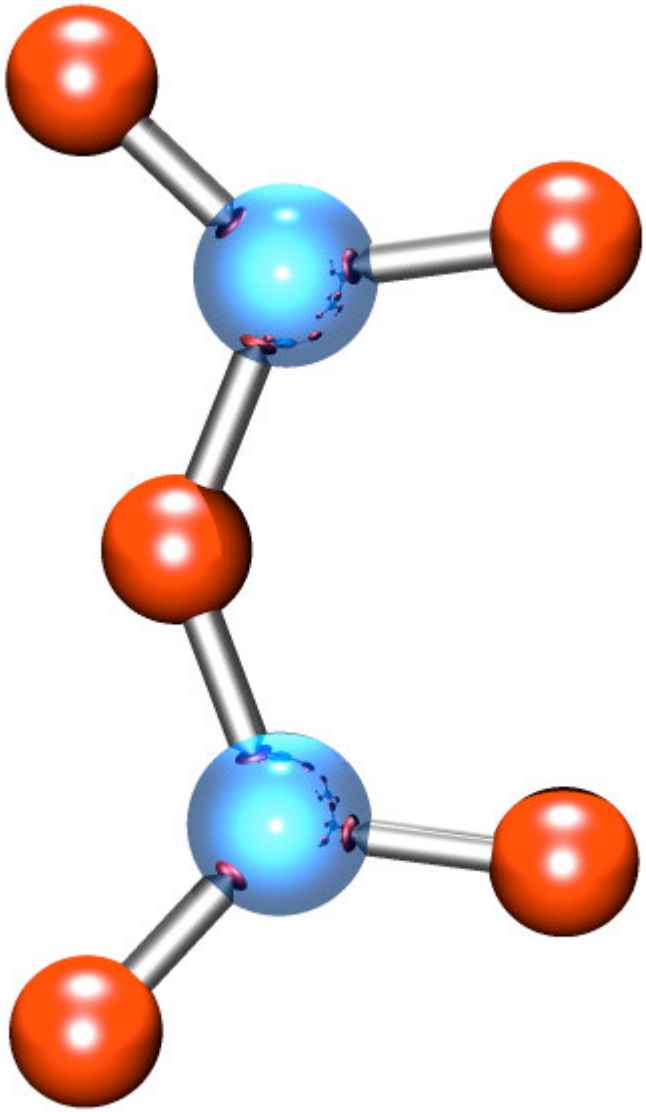
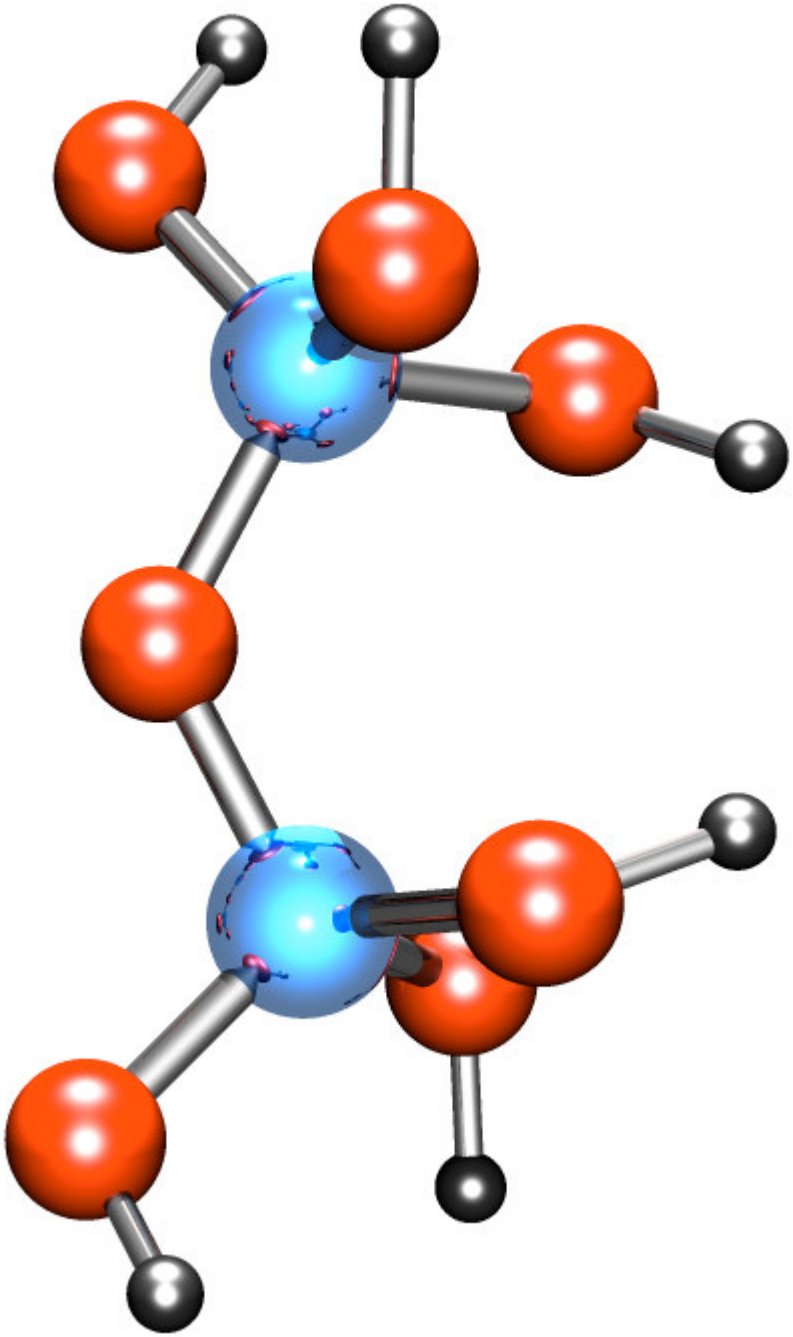
Mg2 B2 O5



Mg B2 O (OH)6



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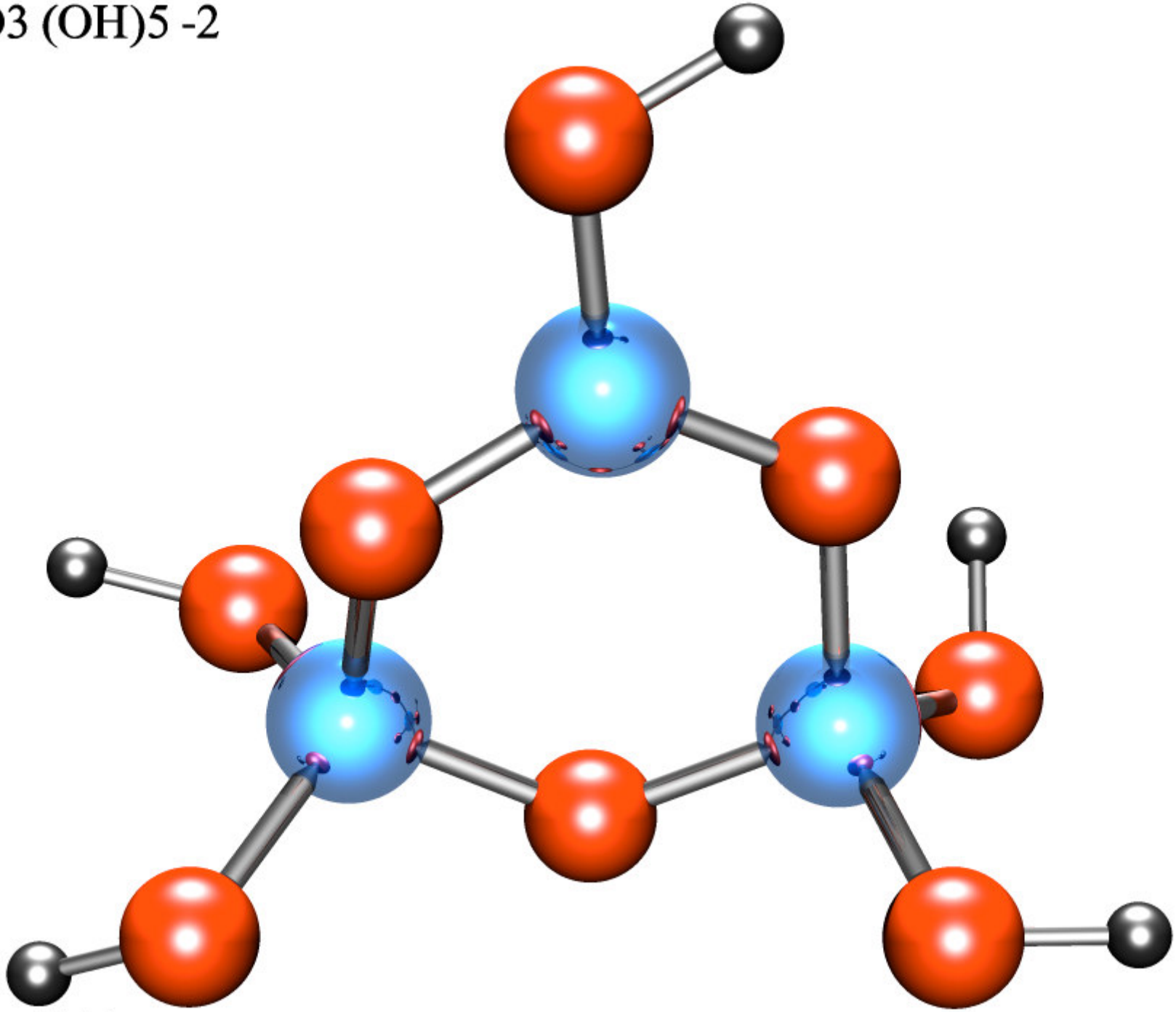
B3 O3 (OH)5 -2



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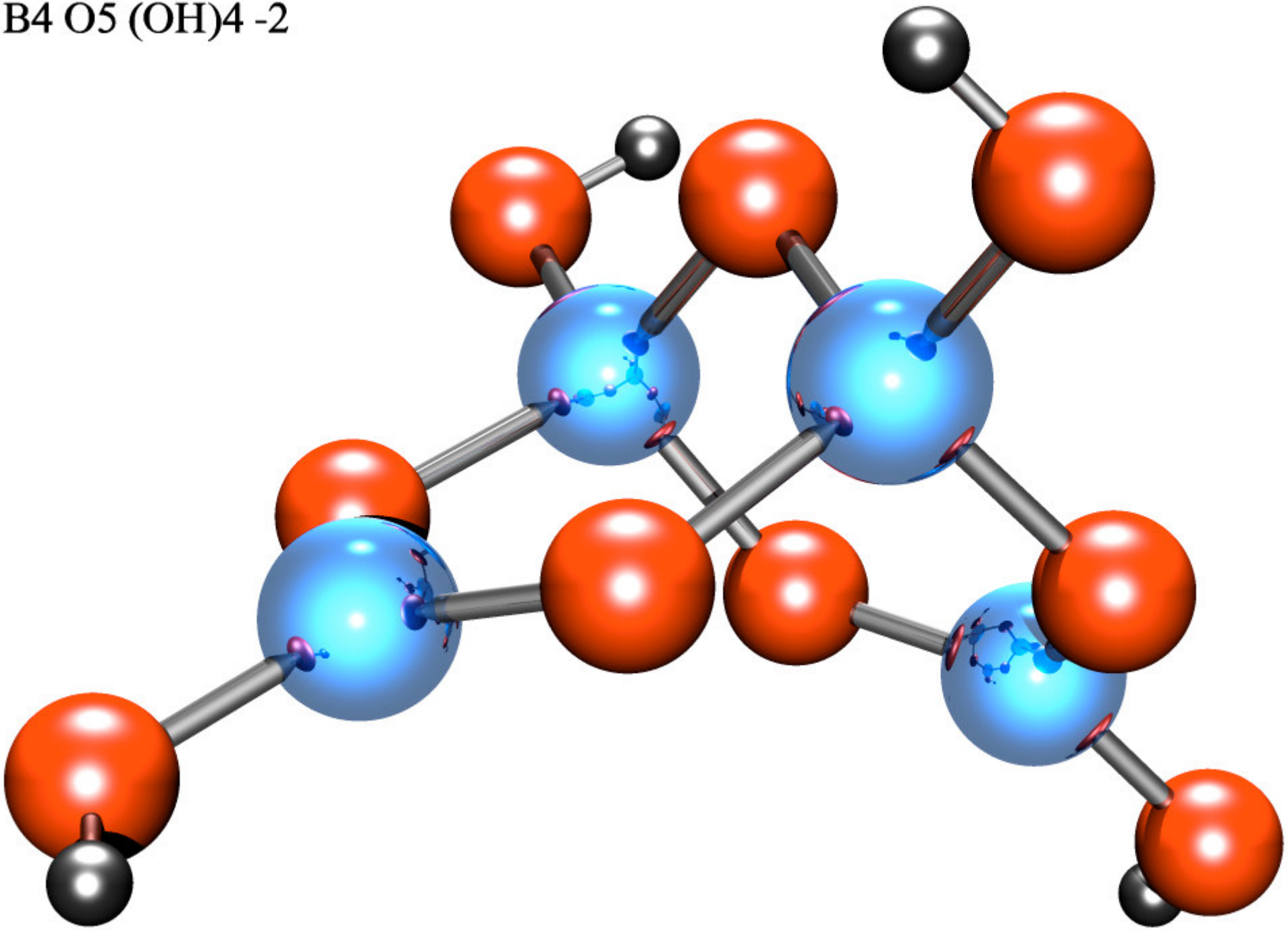
B4 O5 (OH)4 -2



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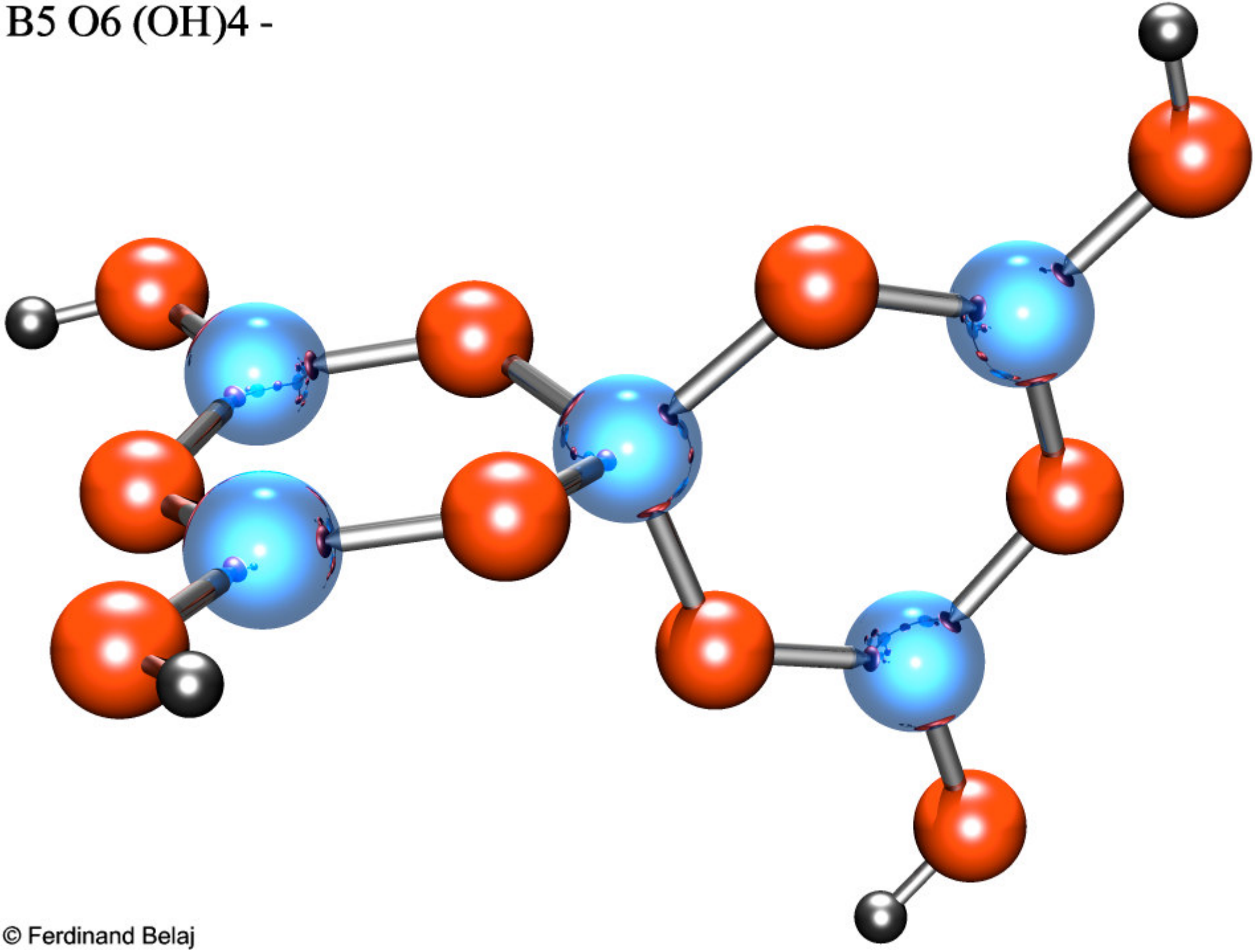
B5 O6 (OH)4 -



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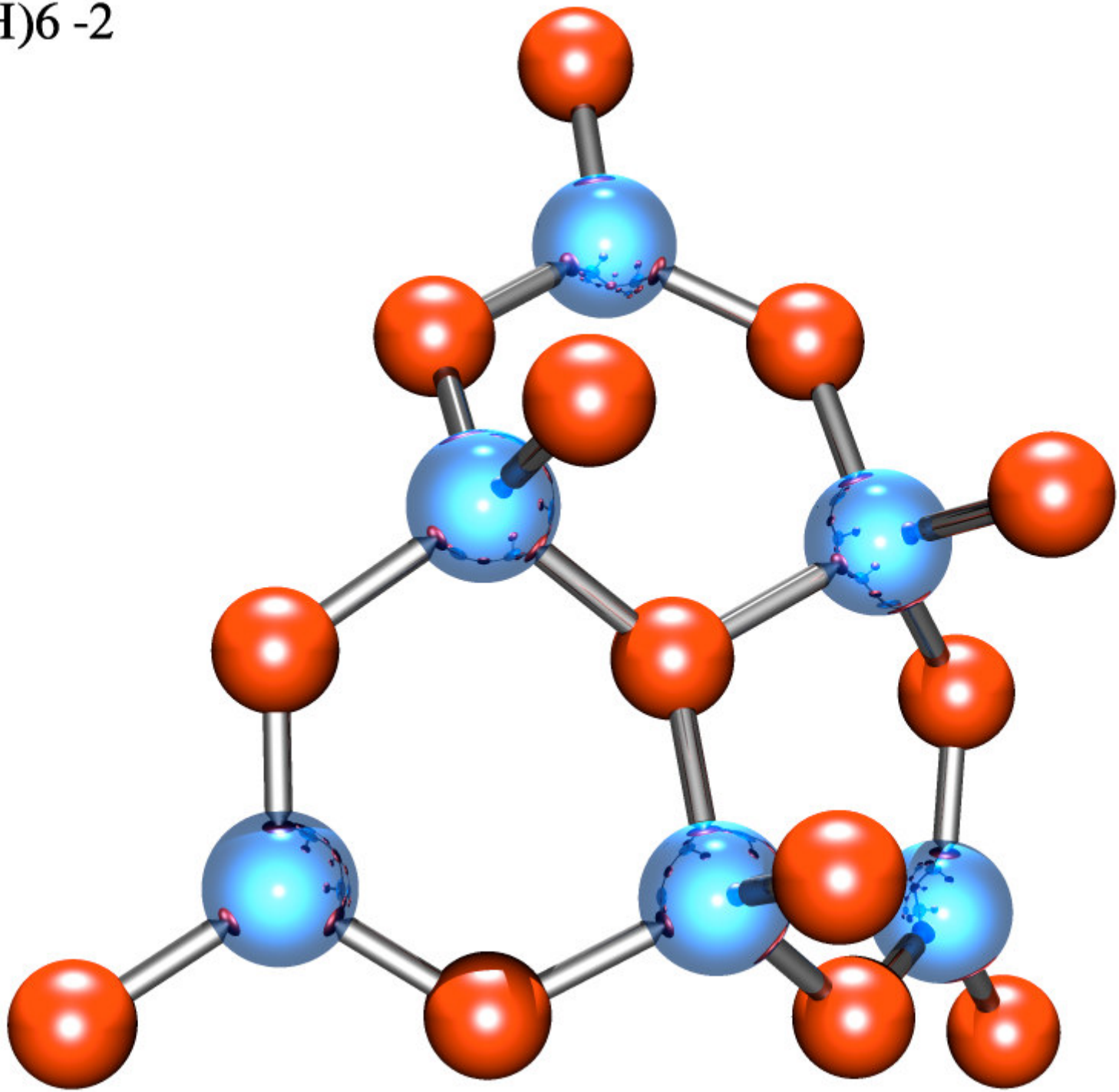
B6 O7 (OH)6 -2



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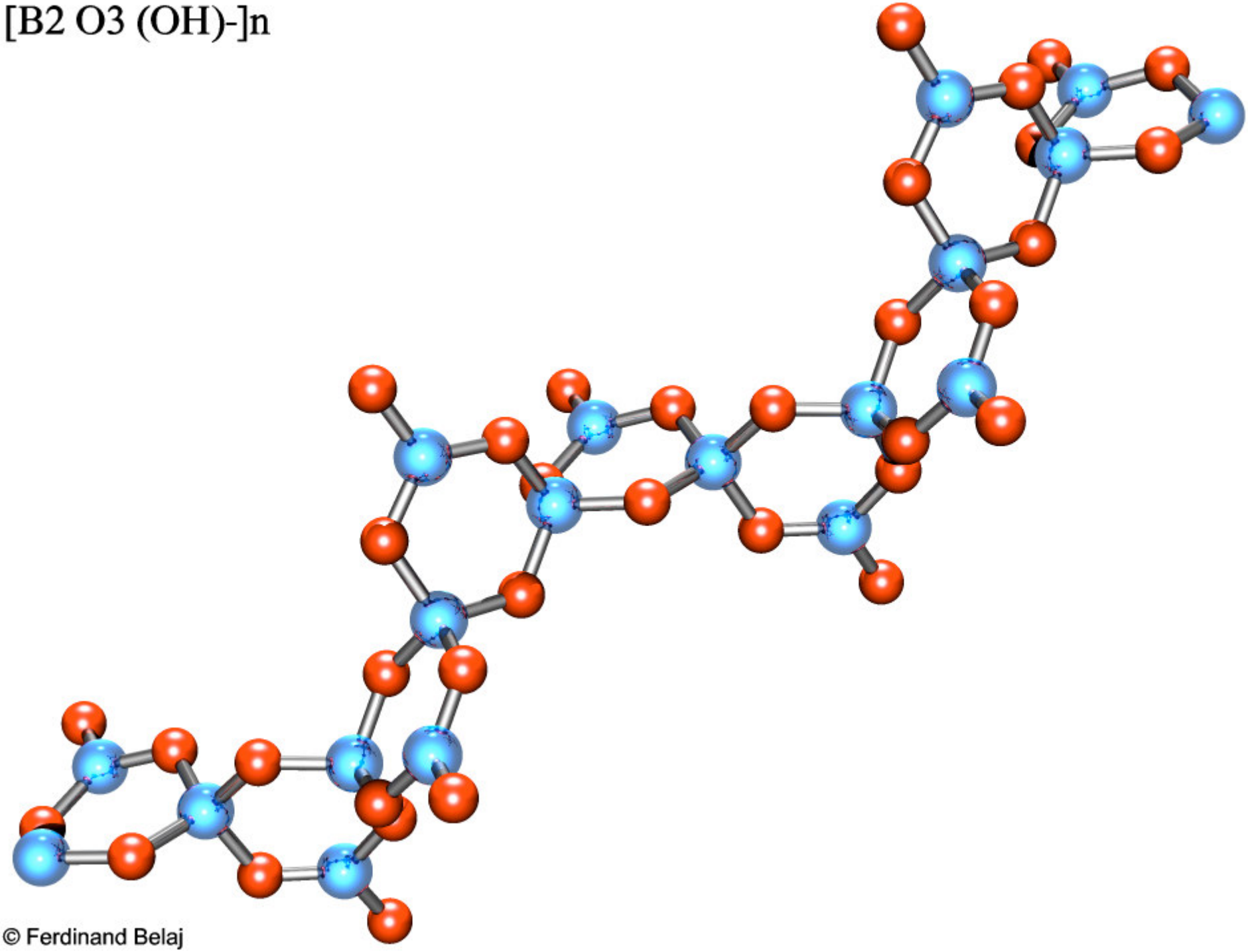
[B2 O3 (OH)-]n



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Borate

d) Heteroborate: Borosilicate analog zu Alumosilicaten

BPO_4: $H_3BO_3 + H_3PO_4 \Rightarrow BPO_4 + 3H_2O$

$2B_2O_3 + P_4O_{10} \Rightarrow 4BPO_4$

nicht $B^{+3}[PO_4^{-3}]$, sondern BO_4- und PO_4-Tetdraeder

kovalent über Ecken verknüpft (vgl. SiO_2)

e) Peroxoborate (= Perborate)

Darstellung:

a) $Na_2B_4O_7 \cdot 10H_2O + 2NaOH \Rightarrow 4NaBO_2 + 11H_2O$

b) $NaBO_2 + H_2O_2 \Rightarrow NaBO_3 + H_2O$

Natriumperborat: $NaBO_3 \cdot 4H_2O = ½Na_2[B_2(O_2)_2(OH)_4] \cdot 6H_2O$

Verwendung:

Borax: löst viele Metalloxide mit charakteristischer Färbung:

Schweißen, Löten, Analytik (“Boraxperle”)

Borsilicatgläser, Emaillen, Porzellan, Keramik

Perborate: Wasch-, Bleich-, Desinfektionsmittel

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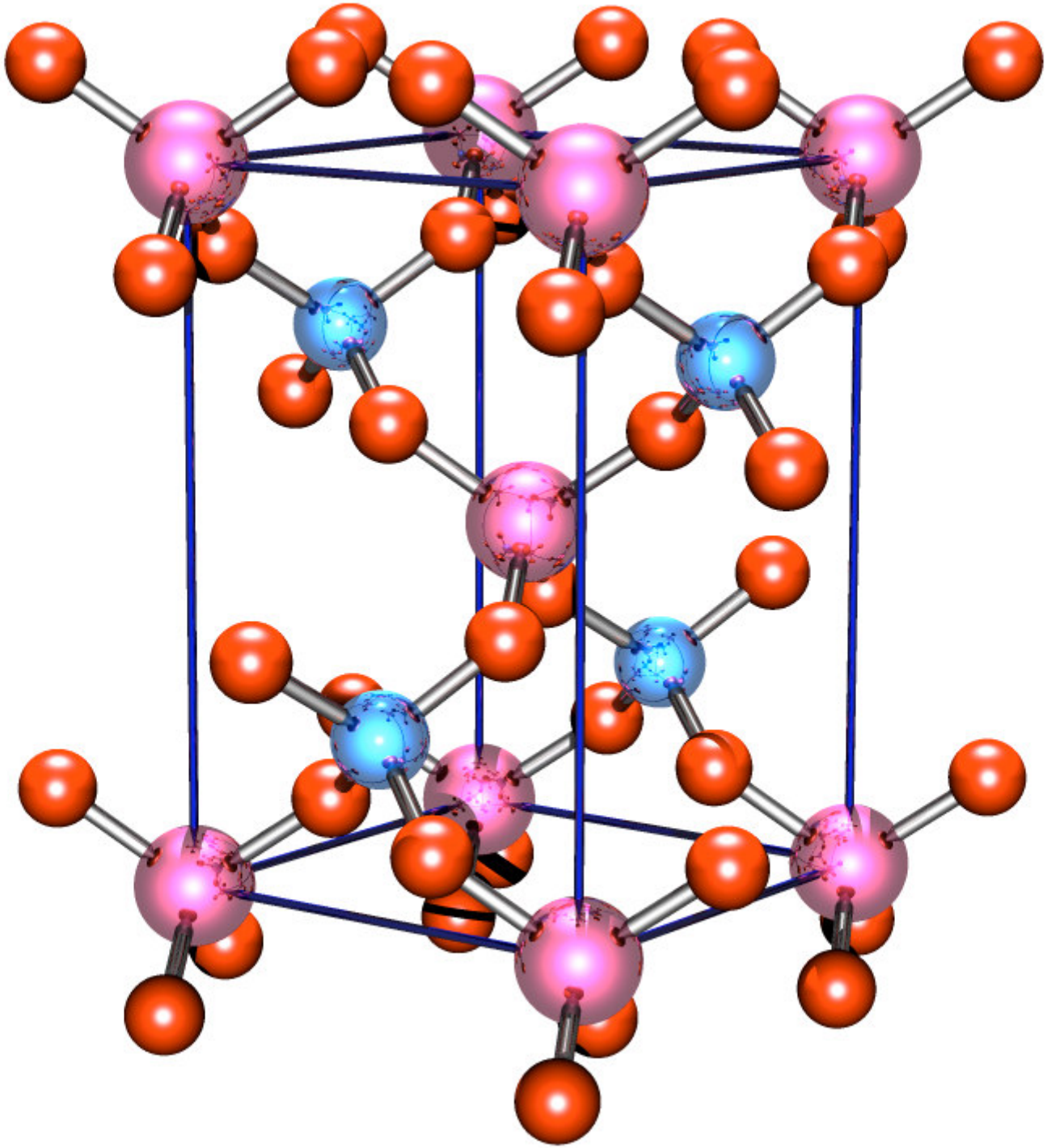
BPO4



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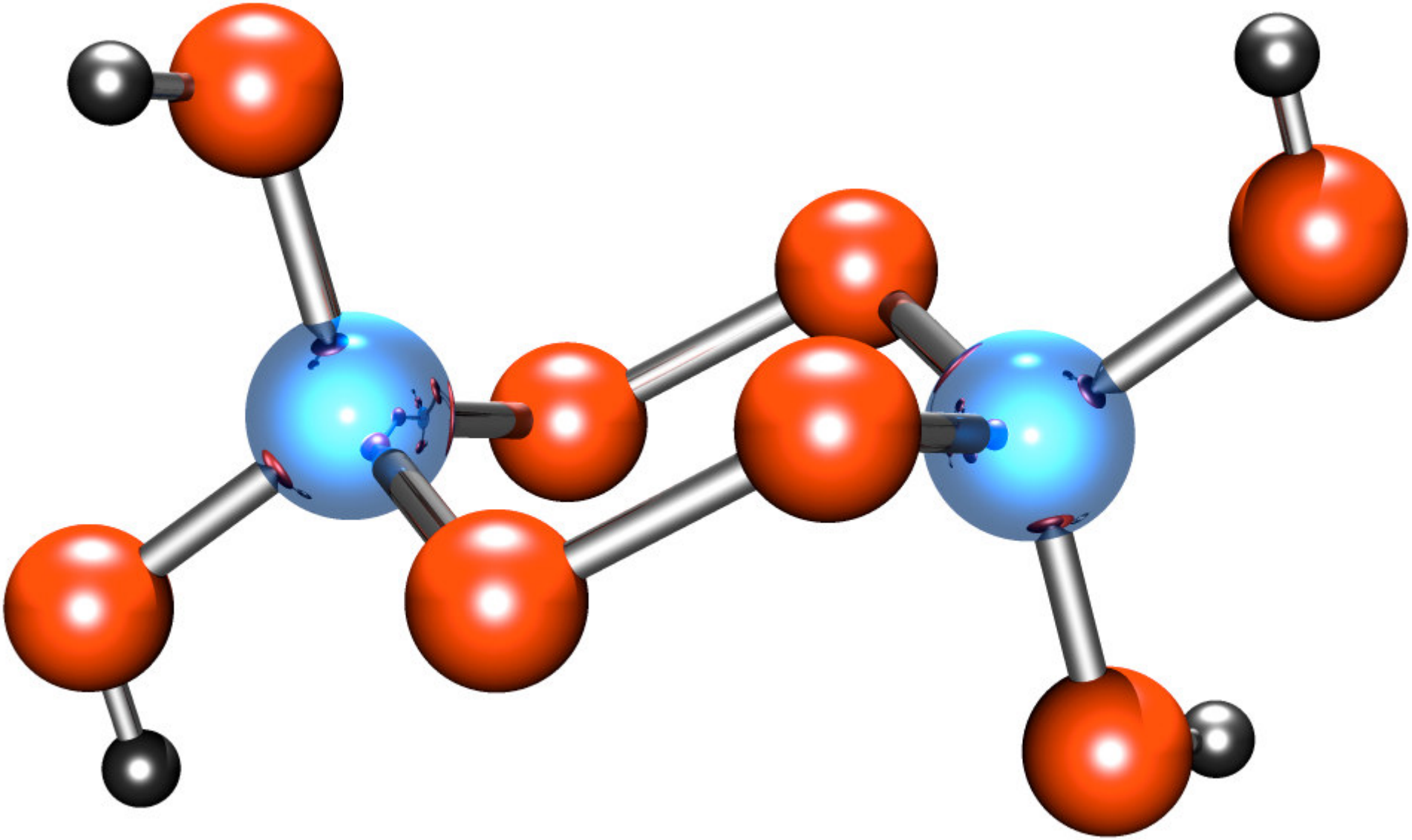
B2 (O2)2 (OH)4 -2



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