

Multifunctional Hybrid Materials Based on Transparent Poly(methyl methacrylate) Reinforced by Lanthanoid Hydroxo Clusters

Electronic Supplementary Information

Selected bond lengths and angles

Selected bond lengths [\AA] and angles [$^\circ$] for $[\text{Eu}_5(\text{OH})_5(\text{abzm})_{10}] \cdot 4\text{Toluene}$.

Eu(1)-O(50)	2.3190(18)
Eu(1)-O(60)	2.3265(18)
Eu(1)-O(3)	2.3599(17)
Eu(1)-O(40)	2.3721(18)
Eu(1)-O(2)	2.3843(17)
Eu(1)-O(30)	2.4050(19)
Eu(1)-O(100) ¹	2.4832(18)
Eu(1)-O(1)	2.6487(4)
Eu(2)-O(10)	2.3078(18)
Eu(2)-O(20)	2.3294(19)
Eu(2)-O(2)	2.3509(17)
Eu(2)-O(90)	2.3555(19)
Eu(2)-O(100)	2.3994(17)
Eu(2)-O(3) ¹	2.3997(18)
Eu(2)-O(40)	2.4928(18)
Eu(2)-O(1)	2.5288(4)
Eu(3)-O(70)	2.331(8)
Eu(3)-O(80)	2.335(8)
Eu(3)-O(110)	2.355(6)
Eu(3)-O(120)	2.393(5)
Eu(3)-O(3)	2.4433(17)
Eu(3)-O(2)	2.4674(17)
O(50)-Eu(1)-O(60)	72.75(7)
O(50)-Eu(1)-O(3)	76.92(6)

O(60)-Eu(1)-O(3)	140.23(7)
O(50)-Eu(1)-O(40)	152.33(6)
O(60)-Eu(1)-O(40)	81.55(6)
O(3)-Eu(1)-O(40)	130.69(6)
O(50)-Eu(1)-O(2)	116.58(6)
O(60)-Eu(1)-O(2)	146.18(7)
O(3)-Eu(1)-O(2)	71.46(6)
O(40)-Eu(1)-O(2)	79.95(6)
O(50)-Eu(1)-O(30)	91.51(6)
O(60)-Eu(1)-O(30)	76.12(7)
O(3)-Eu(1)-O(30)	130.25(6)
O(40)-Eu(1)-O(30)	72.15(6)
O(2)-Eu(1)-O(30)	71.36(6)
O(50)-Eu(1)-O(100) ¹	90.62(6)
O(60)-Eu(1)-O(100) ¹	78.35(6)
O(3)-Eu(1)-O(100) ¹	76.85(6)
O(40)-Eu(1)-O(100) ¹	94.13(6)
O(2)-Eu(1)-O(100) ¹	130.95(6)
O(30)-Eu(1)-O(100) ¹	152.47(6)
O(50)-Eu(1)-O(1)	140.46(5)
O(60)-Eu(1)-O(1)	128.17(7)
O(3)-Eu(1)-O(1)	66.96(6)
O(40)-Eu(1)-O(1)	65.10(5)
O(2)-Eu(1)-O(1)	66.97(6)
O(30)-Eu(1)-O(1)	123.88(5)
O(100) ¹ -Eu(1)-O(1)	66.53(5)
O(10)-Eu(2)-O(20)	73.39(7)
O(10)-Eu(2)-O(2)	76.07(6)
O(20)-Eu(2)-O(2)	137.86(6)
O(10)-Eu(2)-O(90)	82.51(7)
O(20)-Eu(2)-O(90)	78.23(7)
O(2)-Eu(2)-O(90)	125.50(6)
O(10)-Eu(2)-O(100)	147.11(6)
O(20)-Eu(2)-O(100)	80.43(6)

O(2)-Eu(2)-O(100)	136.24(6)
O(90)-Eu(2)-O(100)	72.82(6)
O(10)-Eu(2)-O(3) ¹	115.22(7)
O(20)-Eu(2)-O(3) ¹	147.09(6)
O(2)-Eu(2)-O(3) ¹	73.20(6)
O(90)-Eu(2)-O(3) ¹	71.98(6)
O(100)-Eu(2)-O(3) ¹	77.74(6)
O(10)-Eu(2)-O(40)	93.97(7)
O(20)-Eu(2)-O(40)	75.74(6)
O(2)-Eu(2)-O(40)	78.17(6)
O(90)-Eu(2)-O(40)	153.63(6)
O(100)-Eu(2)-O(40)	98.58(6)
O(3) ¹ -Eu(2)-O(40)	131.66(6)
O(10)-Eu(2)-O(1)	142.57(5)
O(20)-Eu(2)-O(1)	125.37(7)
O(2)-Eu(2)-O(1)	69.51(6)
O(90)-Eu(2)-O(1)	129.80(5)
O(100)-Eu(2)-O(1)	69.70(5)
O(3) ¹ -Eu(2)-O(1)	68.43(6)
O(40)-Eu(2)-O(1)	65.35(5)
O(70)-Eu(3)-O(70) ¹	118.8(5)
O(70)-Eu(3)-O(80)	73.1(3)
O(70)-Eu(3)-O(80) ¹	77.0(3)
O(80)-Eu(3)-O(80) ¹	119.2(3)
O(70) ¹ -Eu(3)-O(110)	116.59(12)
O(80)-Eu(3)-O(110)	70.2(2)
O(80) ¹ -Eu(3)-O(110)	77.9(2)
O(110)-Eu(3)-O(110) ¹	114.5(3)
O(70)-Eu(3)-O(120) ¹	77.5(3)
O(110)-Eu(3)-O(120) ¹	74.5(2)
O(70)-Eu(3)-O(120)	71.4(3)
O(80)-Eu(3)-O(120)	117.63(12)
O(110)-Eu(3)-O(120)	72.5(2)
O(120) ¹ -Eu(3)-O(120)	116.7(3)

O(70)-Eu(3)-O(3) ¹	133.1(2)
O(80)-Eu(3)-O(3) ¹	74.76(19)
O(110)-Eu(3)-O(3) ¹	131.88(18)
O(120)-Eu(3)-O(3) ¹	155.27(13)
O(70)-Eu(3)-O(3)	85.4(2)
O(70) ¹ -Eu(3)-O(3)	133.1(2)
O(80)-Eu(3)-O(3)	149.57(17)
O(80) ¹ -Eu(3)-O(3)	74.76(19)
O(110)-Eu(3)-O(3)	88.47(17)
O(120)-Eu(3)-O(3)	73.34(14)
O(3) ¹ -Eu(3)-O(3)	107.38(8)
O(70)-Eu(3)-O(2) ¹	152.7(2)
O(80)-Eu(3)-O(2) ¹	134.01(19)
O(110)-Eu(3)-O(2) ¹	155.50(17)
O(120)-Eu(3)-O(2) ¹	89.13(13)
O(3)-Eu(3)-O(2) ¹	70.45(6)
O(70)-Eu(3)-O(2)	73.2(2)
O(80)-Eu(3)-O(2)	84.36(17)
O(110)-Eu(3)-O(2)	74.21(18)
O(120)-Eu(3)-O(2)	129.32(13)
O(3)-Eu(3)-O(2)	68.69(6)
Eu(2)-O(1)-Eu(2) ¹	161.80(11)
Eu(2)-O(1)-Eu(1) ¹	88.855(18)
Eu(2)-O(1)-Eu(1)	88.133(18)
Eu(1) ¹ -O(1)-Eu(1)	160.87(10)
Eu(2)-O(2)-Eu(1)	99.04(7)
Eu(2)-O(2)-Eu(3)	108.18(6)
Eu(1)-O(2)-Eu(3)	108.89(7)
Eu(1)-O(3)-Eu(2) ¹	99.22(7)
Eu(1)-O(3)-Eu(3)	110.52(7)
Eu(2) ¹ -O(3)-Eu(3)	107.39(6)

Symmetry transformations used to generate equivalent atoms: ¹ -x,y,-z+1/2

Selected bond lengths [Å] and angles [°] for [Tb₅(OH)₅(**abzm**)₁₀]**·**4Toluene.

Tb(1)-O(50)	2.296(2)
Tb(1)-O(60)	2.308(3)
Tb(1)-O(3)	2.344(2)
Tb(1)-O(40)	2.346(2)
Tb(1)-O(2)	2.357(2)
Tb(1)-O(30)	2.378(3)
Tb(1)-O(100) ¹	2.452(2)
Tb(1)-O(1)	2.6212(7)
Tb(1)...Tb(2)	3.5651(2)
Tb(1)...Tb(2) ¹	3.5787(3)
Tb(1)...Tb(3)	3.9068(3)
Tb(2)-O(10)	2.287(3)
Tb(2)-O(20)	2.297(3)
Tb(2)-O(2)	2.324(2)
Tb(2)-O(90)	2.341(2)
Tb(2)-O(3) ¹	2.370(3)
Tb(2)-O(100)	2.386(2)
Tb(2)-O(40)	2.475(2)
Tb(2)-O(1)	2.5048(7)
Tb(2)...Tb(1) ¹	3.5787(3)
Tb(2)...Tb(3)	3.8577(3)
Tb(3)-O(70)	2.261(7)
Tb(3)-O(80)	2.331(7)
Tb(3)-O(120)	2.358(8)
Tb(3)-O(110)	2.379(7)
Tb(3)-O(3)	2.417(2)
Tb(3)-O(2)	2.440(2)
O(50)-Tb(1)-O(60)	73.64(9)
O(50)-Tb(1)-O(3)	76.26(8)
O(60)-Tb(1)-O(3)	140.33(9)
O(50)-Tb(1)-O(40)	152.74(9)
O(60)-Tb(1)-O(40)	81.25(9)

O(3)-Tb(1)-O(40)	130.97(8)
O(50)-Tb(1)-O(2)	115.85(9)
O(60)-Tb(1)-O(2)	146.16(9)
O(3)-Tb(1)-O(2)	71.40(8)
O(40)-Tb(1)-O(2)	80.04(9)
O(50)-Tb(1)-O(30)	90.45(9)
O(60)-Tb(1)-O(30)	76.02(9)
O(3)-Tb(1)-O(30)	129.60(9)
O(40)-Tb(1)-O(30)	73.05(9)
O(2)-Tb(1)-O(30)	71.66(8)
O(50)-Tb(1)-O(100) ¹	90.75(9)
O(60)-Tb(1)-O(100) ¹	77.97(9)
O(3)-Tb(1)-O(100) ¹	77.20(9)
O(40)-Tb(1)-O(100) ¹	94.31(9)
O(2)-Tb(1)-O(100) ¹	131.32(8)
O(30)-Tb(1)-O(100) ¹	152.48(9)
O(50)-Tb(1)-O(1)	140.49(7)
O(60)-Tb(1)-O(1)	127.55(10)
O(3)-Tb(1)-O(1)	67.55(8)
O(40)-Tb(1)-O(1)	64.87(8)
O(2)-Tb(1)-O(1)	67.27(8)
O(30)-Tb(1)-O(1)	124.71(6)
O(100) ¹ -Tb(1)-O(1)	66.72(7)
O(10)-Tb(2)-O(20)	74.06(10)
O(10)-Tb(2)-O(2)	75.54(9)
O(20)-Tb(2)-O(2)	137.76(8)
O(10)-Tb(2)-O(90)	81.71(9)
O(20)-Tb(2)-O(90)	78.25(9)
O(2)-Tb(2)-O(90)	125.10(9)
O(10)-Tb(2)-O(3) ¹	114.48(10)
O(20)-Tb(2)-O(3) ¹	147.12(8)
O(2)-Tb(2)-O(3) ¹	73.25(8)
O(90)-Tb(2)-O(3) ¹	72.14(8)
O(10)-Tb(2)-O(100)	147.51(9)

O(20)-Tb(2)-O(100)	80.30(9)
O(2)-Tb(2)-O(100)	136.35(8)
O(90)-Tb(2)-O(100)	73.70(9)
O(3) ¹ -Tb(2)-O(100)	77.99(9)
O(10)-Tb(2)-O(40)	94.07(9)
O(20)-Tb(2)-O(40)	75.61(9)
O(2)-Tb(2)-O(40)	78.05(8)
O(90)-Tb(2)-O(40)	153.66(9)
O(3) ¹ -Tb(2)-O(40)	131.89(8)
O(100)-Tb(2)-O(40)	98.60(8)
O(10)-Tb(2)-O(1)	142.29(7)
O(20)-Tb(2)-O(1)	124.70(11)
O(2)-Tb(2)-O(1)	69.79(9)
O(90)-Tb(2)-O(1)	130.85(7)
O(3) ¹ -Tb(2)-O(1)	69.18(9)
O(100)-Tb(2)-O(1)	69.60(7)
O(40)-Tb(2)-O(1)	64.96(7)
O(70)-Tb(3)-O(70) ¹	126.1(3)
O(70)-Tb(3)-O(80)	76.3(3)
O(70)-Tb(3)-O(80) ¹	78.9(3)
O(80)-Tb(3)-O(80) ¹	123.5(4)
O(70)-Tb(3)-O(120) ¹	77.9(3)
O(70)-Tb(3)-O(120)	72.8(3)
O(80)-Tb(3)-O(120)	117.63(16)
O(120) ¹ -Tb(3)-O(120)	112.1(4)
O(80)-Tb(3)-O(110)	71.9(3)
O(120)-Tb(3)-O(110)	69.9(3)
O(70)-Tb(3)-O(110) ¹	117.88(15)
O(80)-Tb(3)-O(110) ¹	76.5(3)
O(120)-Tb(3)-O(110) ¹	72.6(3)
O(110)-Tb(3)-O(110) ¹	109.7(4)
O(70)-Tb(3)-O(3) ¹	131.1(2)
O(80)-Tb(3)-O(3) ¹	72.1(2)
O(120)-Tb(3)-O(3) ¹	155.80(19)

O(110)-Tb(3)-O(3) ¹	133.1(2)
O(70)-Tb(3)-O(3)	82.87(19)
O(80)-Tb(3)-O(3)	149.96(18)
O(120)-Tb(3)-O(3)	75.3(2)
O(110)-Tb(3)-O(3)	89.7(2)
O(3) ¹ -Tb(3)-O(3)	107.81(12)
O(70)-Tb(3)-O(2) ¹	151.6(2)
O(80)-Tb(3)-O(2) ¹	132.1(2)
O(120)-Tb(3)-O(2) ¹	90.71(18)
O(110)-Tb(3)-O(2) ¹	155.6(2)
O(3)-Tb(3)-O(2) ¹	70.43(8)
O(70)-Tb(3)-O(2)	69.91(19)
O(80)-Tb(3)-O(2)	83.70(18)
O(120)-Tb(3)-O(2)	130.4(2)
O(110)-Tb(3)-O(2)	76.8(2)
O(3)-Tb(3)-O(2)	68.78(8)
O(2) ¹ -Tb(3)-O(2)	107.47(12)
Tb(2)-O(1)-Tb(2) ¹	160.52(17)
Tb(2)-O(1)-Tb(1) ¹	88.53(3)
Tb(2)-O(1)-Tb(1)	88.10(3)
Tb(1) ¹ -O(1)-Tb(1)	159.98(16)
Tb(2)-O(2)-Tb(1)	99.23(10)
Tb(2)-O(2)-Tb(3)	108.15(9)
Tb(1)-O(2)-Tb(3)	109.07(9)
Tb(1)-O(3)-Tb(2) ¹	98.79(10)
Tb(1)-O(3)-Tb(3)	110.29(9)
Tb(2) ¹ -O(3)-Tb(3)	107.38(9)
Tb(2)-O(100)-Tb(1) ¹	95.40(9)

Symmetry transformations used to generate equivalent atoms: ¹ -x,y,-z+1/2

Selected bond lengths [Å] and angles [°] for [Ho₅(OH)₅(**abzm**)₁₀]·4Toluene.

Ho(1)-O(50)	2.265(2)
-------------	----------

Ho(1)-O(60)	2.279(2)
Ho(1)-O(3)	2.308(2)
Ho(1)-O(40)	2.318(2)
Ho(1)-O(2)	2.324(2)
Ho(1)-O(30)	2.362(2)
Ho(1)-O(100) ¹	2.430(2)
Ho(1)-O(1)	2.5779(5)
Ho(1)..Ho(2)	3.51086(19)
Ho(1)..Ho(2) ¹	3.53528(18)
Ho(1)..Ho(3)	3.85716(19)
Ho(2)-O(10)	2.263(2)
Ho(2)-O(20)	2.279(2)
Ho(2)-O(2)	2.297(2)
Ho(2)-O(90)	2.313(2)
Ho(2)-O(3) ¹	2.339(2)
Ho(2)-O(100)	2.347(2)
Ho(2)-O(40)	2.436(2)
Ho(2)-O(1)	2.4760(5)
Ho(2)...Ho(3)	3.8198(2)
Ho(3)-O(70)	2.275(7)
Ho(3)-O(80)	2.302(6)
Ho(3)-O(110)	2.323(8)
Ho(3)-O(120)	2.334(7)
Ho(3)-O(3)	2.384(2)
Ho(3)-O(2)	2.416(2)
O(50)-Ho(1)-O(60)	74.41(8)
O(50)-Ho(1)-O(3)	75.98(7)
O(60)-Ho(1)-O(3)	140.25(8)
O(50)-Ho(1)-O(40)	152.97(8)
O(60)-Ho(1)-O(40)	81.24(8)
O(3)-Ho(1)-O(40)	131.05(7)
O(50)-Ho(1)-O(2)	114.50(8)
O(60)-Ho(1)-O(2)	146.13(8)

O(3)-Ho(1)-O(2)	71.46(7)
O(40)-Ho(1)-O(2)	80.12(8)
O(50)-Ho(1)-O(30)	89.05(8)
O(60)-Ho(1)-O(30)	76.10(8)
O(3)-Ho(1)-O(30)	129.22(8)
O(40)-Ho(1)-O(30)	73.65(8)
O(2)-Ho(1)-O(30)	71.64(7)
O(50)-Ho(1)-O(100) ¹	91.82(8)
O(60)-Ho(1)-O(100) ¹	77.95(8)
O(3)-Ho(1)-O(100) ¹	77.10(7)
O(40)-Ho(1)-O(100) ¹	94.45(7)
O(2)-Ho(1)-O(100) ¹	131.46(7)
O(30)-Ho(1)-O(100) ¹	152.78(8)
O(50)-Ho(1)-O(1)	140.38(6)
O(60)-Ho(1)-O(1)	127.61(9)
O(3)-Ho(1)-O(1)	67.27(7)
O(40)-Ho(1)-O(1)	65.27(6)
O(2)-Ho(1)-O(1)	67.57(7)
O(30)-Ho(1)-O(1)	125.56(6)
O(100) ¹ -Ho(1)-O(1)	66.53(6)
O(10)-Ho(2)-O(20)	75.11(8)
O(10)-Ho(2)-O(2)	74.98(8)
O(20)-Ho(2)-O(2)	138.07(7)
O(10)-Ho(2)-O(90)	81.26(9)
O(20)-Ho(2)-O(90)	78.27(8)
O(2)-Ho(2)-O(90)	124.72(8)
O(10)-Ho(2)-O(3) ¹	114.02(8)
O(20)-Ho(2)-O(3) ¹	147.30(7)
O(2)-Ho(2)-O(3) ¹	72.96(7)
O(90)-Ho(2)-O(3) ¹	72.65(8)
O(10)-Ho(2)-O(100)	148.10(8)
O(20)-Ho(2)-O(100)	79.93(7)
O(2)-Ho(2)-O(100)	136.28(7)
O(90)-Ho(2)-O(100)	74.41(8)

O(3) ¹ -Ho(2)-O(100)	78.16(7)
O(10)-Ho(2)-O(40)	94.31(8)
O(20)-Ho(2)-O(40)	75.43(8)
O(2)-Ho(2)-O(40)	78.23(7)
O(90)-Ho(2)-O(40)	153.58(8)
O(3)#1-Ho(2)-O(40)	131.64(7)
O(100)-Ho(2)-O(40)	98.35(7)
O(10)-Ho(2)-O(1)	142.00(7)
O(20)-Ho(2)-O(1)	124.61(9)
O(2)-Ho(2)-O(1)	69.77(7)
O(90)-Ho(2)-O(1)	131.08(6)
O(3) ¹ -Ho(2)-O(1)	68.61(7)
O(100)-Ho(2)-O(1)	69.44(6)
O(40)-Ho(2)-O(1)	65.28(6)
O(70)-Ho(3)-O(70) ¹	119.3(4)
O(70)-Ho(3)-O(80)	75.0(3)
O(70) ¹ -Ho(3)-O(80)	77.7(3)
O(80) ¹ -Ho(3)-O(80)	124.3(3)
O(70) ¹ -Ho(3)-O(110)	116.98(12)
O(80) ¹ -Ho(3)-O(110)	79.1(3)
O(80)-Ho(3)-O(110)	71.7(3)
O(110)-Ho(3)-O(110) ¹	114.7(5)
O(110)-Ho(3)-O(120) ¹	72.6(3)
O(70)-Ho(3)-O(120)	71.2(2)
O(70) ¹ -Ho(3)-O(120)	76.0(3)
O(80)-Ho(3)-O(120)	117.92(14)
O(110)-Ho(3)-O(120)	72.3(3)
O(120) ¹ -Ho(3)-O(120)	111.9(3)
O(70)-Ho(3)-O(3)	85.4(2)
O(80)-Ho(3)-O(3)	149.14(14)
O(110)-Ho(3)-O(3)	88.8(2)
O(120)-Ho(3)-O(3)	76.06(17)
O(70)-Ho(3)-O(3) ¹	133.1(2)
O(80)-Ho(3)-O(3) ¹	72.43(16)

O(110)-Ho(3)-O(3) ¹	131.6(2)
O(120)-Ho(3)-O(3) ¹	155.32(15)
O(3)-Ho(3)-O(3) ¹	106.83(10)
O(70)-Ho(3)-O(2)1	152.4(2)
O(80)-Ho(3)-O(2)1	132.56(16)
O(120)-Ho(3)-O(2)1	90.35(13)
O(3)-Ho(3)-O(2) ¹	70.10(7)
O(70)-Ho(3)-O(2)	73.2(2)
O(80)-Ho(3)-O(2)	82.88(13)
O(110)-Ho(3)-O(2)	74.2(2)
O(110) ¹ -Ho(3)-O(2)	155.6(2)
O(120)-Ho(3)-O(2)	131.05(17)
O(3)-Ho(3)-O(2)	68.61(7)
O(2) ¹ -Ho(3)-O(2)	107.47(10)
Ho(2) ¹ -O(1)-Ho(2)	160.93(13)
Ho(2)-O(1)-Ho(1)	87.98(2)
Ho(2)-O(1)-Ho(1) ¹	88.75(2)
Ho(1)-O(1)-Ho(1) ¹	160.16(12)
Ho(2)-O(2)-Ho(1)	98.88(8)
Ho(2)-O(2)-Ho(3)	108.25(7)
Ho(1)-O(2)-Ho(3)	108.91(8)
Ho(1)-O(3)-Ho(2) ¹	99.06(8)
Ho(1)-O(3)-Ho(3)	110.58(8)
Ho(2) ¹ -O(3)-Ho(3)	107.97(7)

Symmetry transformations used to generate equivalent atoms: ¹ -x,y,-z+1/2

Raman spectrum of the abzmH ligand

