Electronic Supplementary Material (ESI) for RSC Advances.


# Supporting Information

## Lanthanide MOFs Constructed Based on a Difunctional Ligand with Bimodal Emission and $Eu^{3+}$ doped $Dy^{3+}$ Materials: White Emission and Color Tuning

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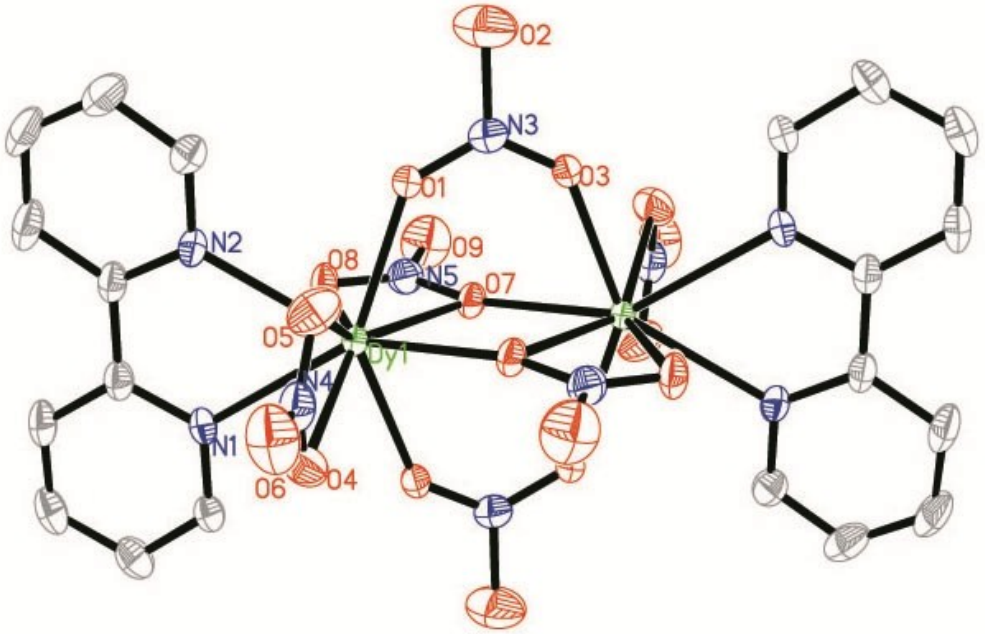



**Fig. S1** The structure unit of complex **1·Dy**.

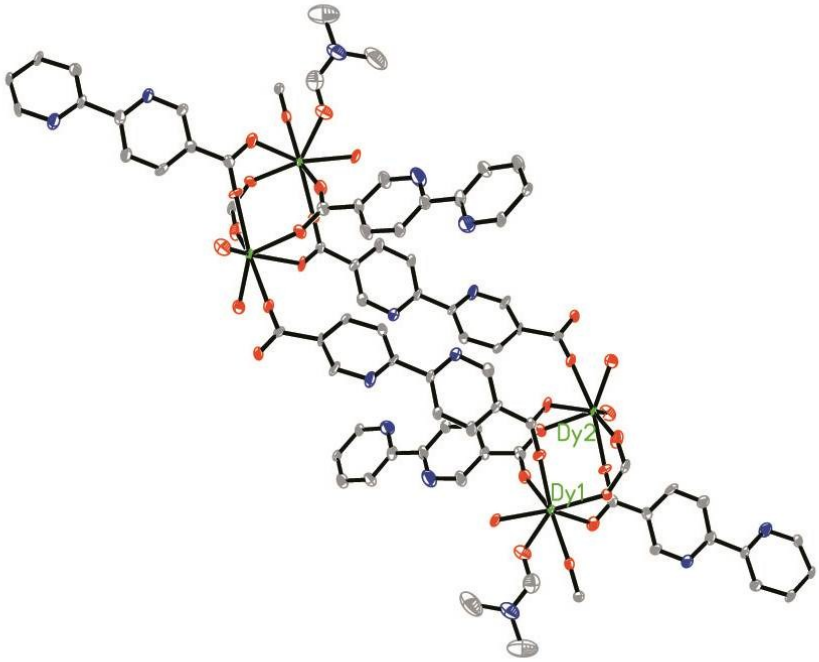



**Fig. S2** The structure unit of complex **3·Dy**.

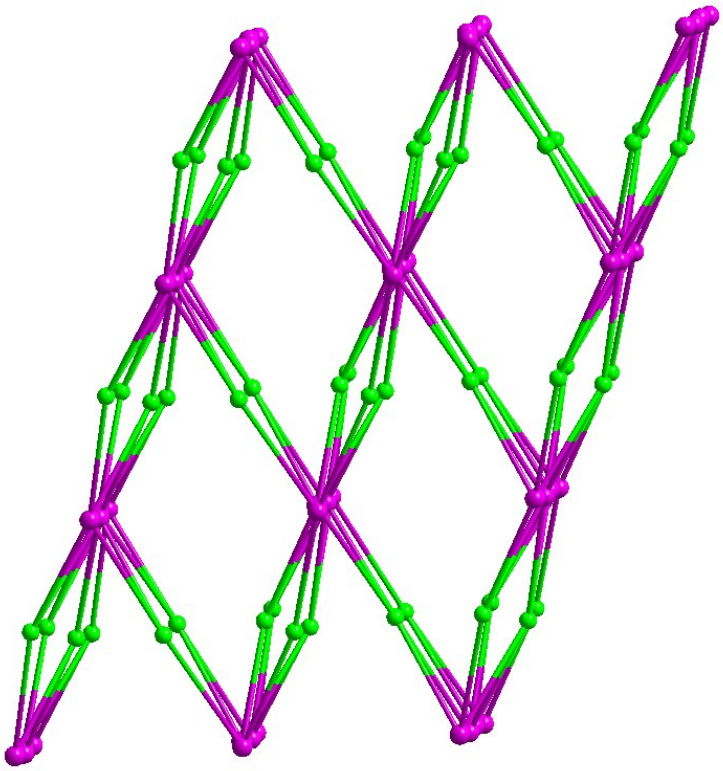


**Fig. S3** The topology structure of **3**·**Dy**.

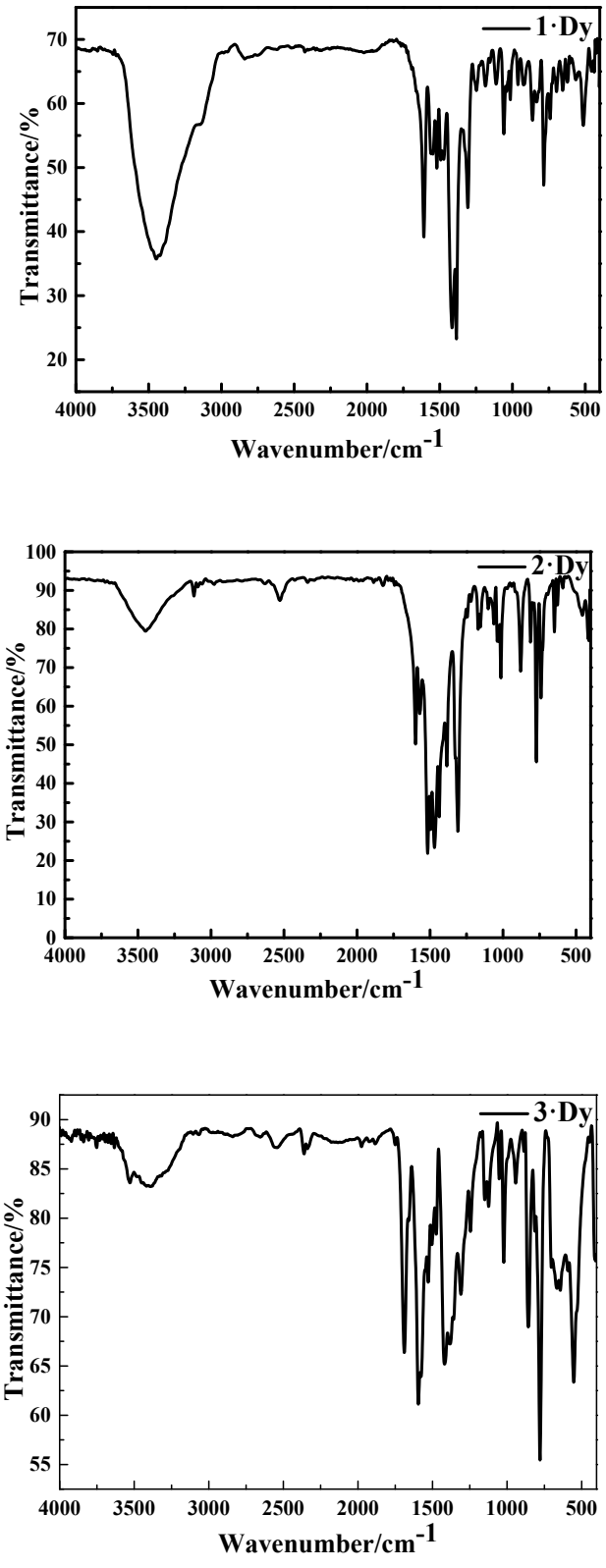



**Fig. S4** Infrared spectra of complex **1·Dy~3·Dy** recorded from a KBr pellet.

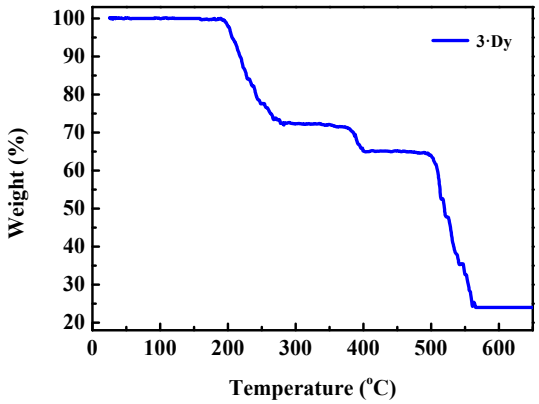
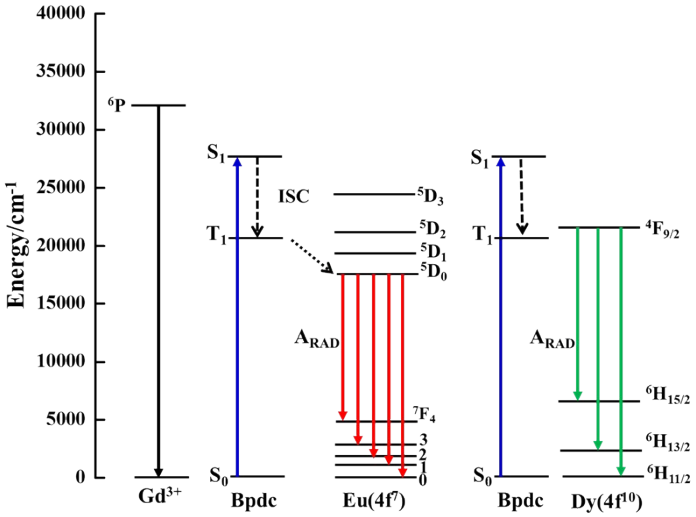



**Fig. S5** Thermal gravimetric curves of complex **3·Dy**.




**Scheme S1.** Schematic of the energy absorption, migration and emission process of lanthanide complexes.

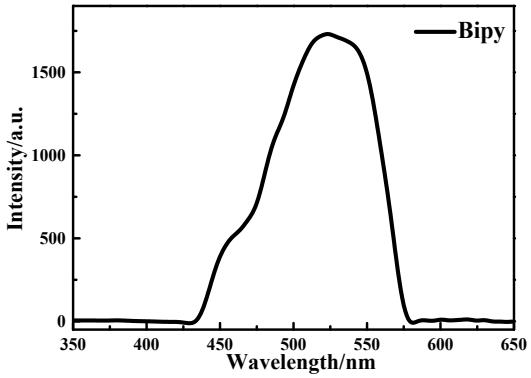



**Fig. S6** The luminescence property of 2,2-bipyridine in solid state at 298 K.

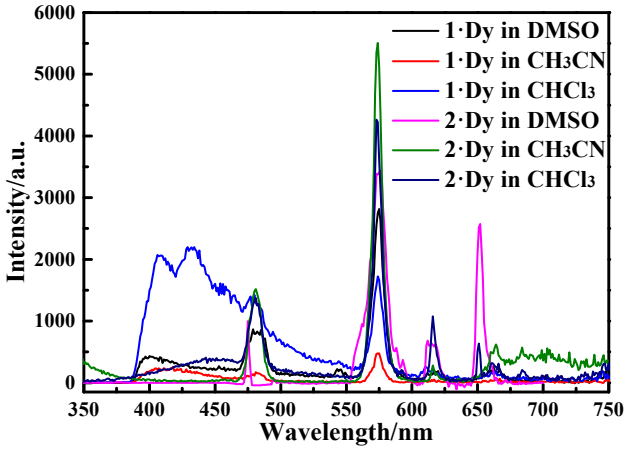



**Fig. S7** The luminescence property of **1·Dy** and **2·Dy** in different solvents.

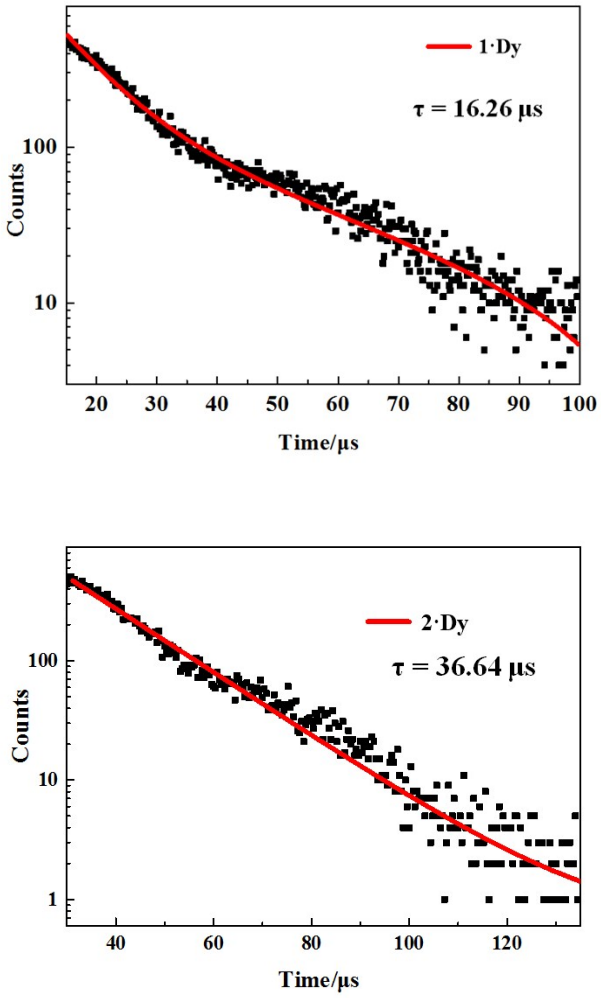



**Fig. S8** Luminescence decay curves of **1·Dy** and **2·Dy** in the solid state at 298 K.

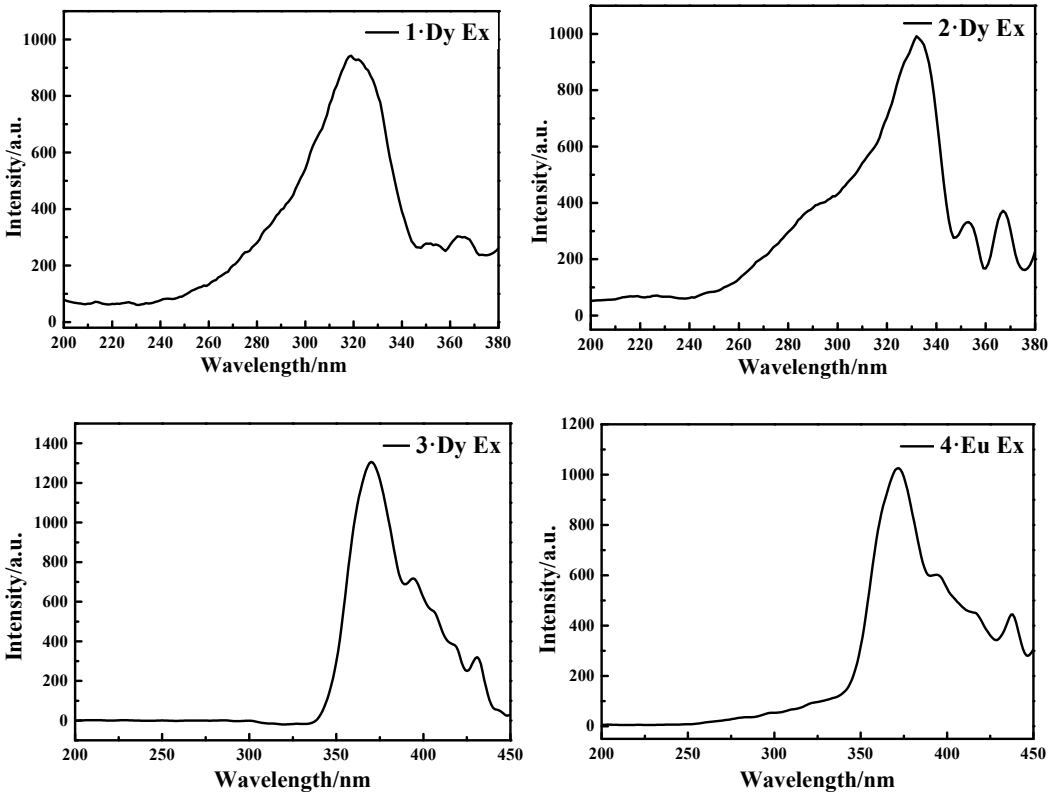



**Fig. S9** Excitation spectra of complex **1·Dy**, **2·Dy**, **3·Dy** and **4·Eu**.

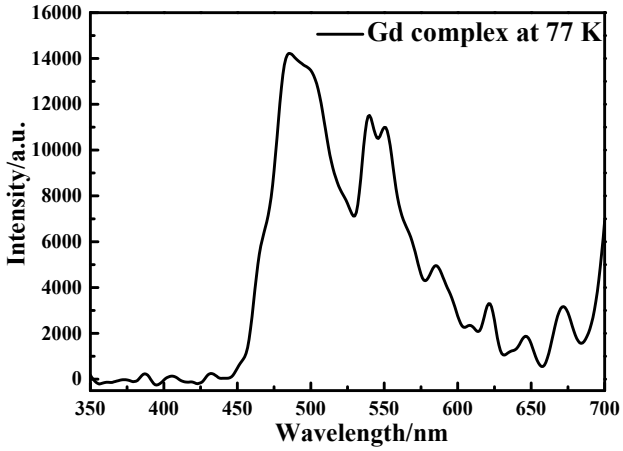



**Fig. S10** Phosphorescence spectra of Gd complex at 77 K.

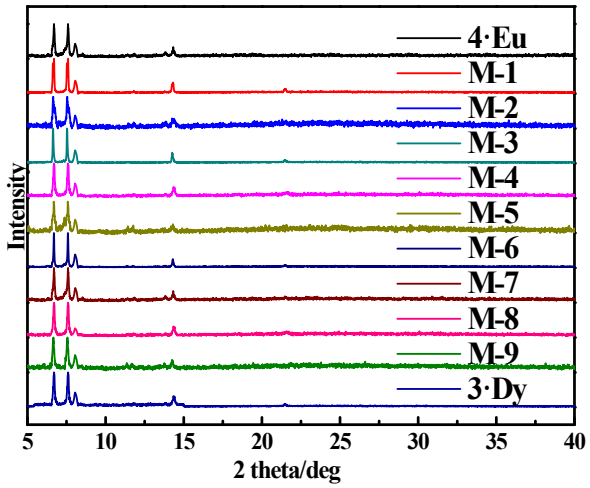



**Fig. S11** Experimental and simulated PXRD patterns of complex **3·Dy**, 4·**Eu** and **M-1~M-9**.

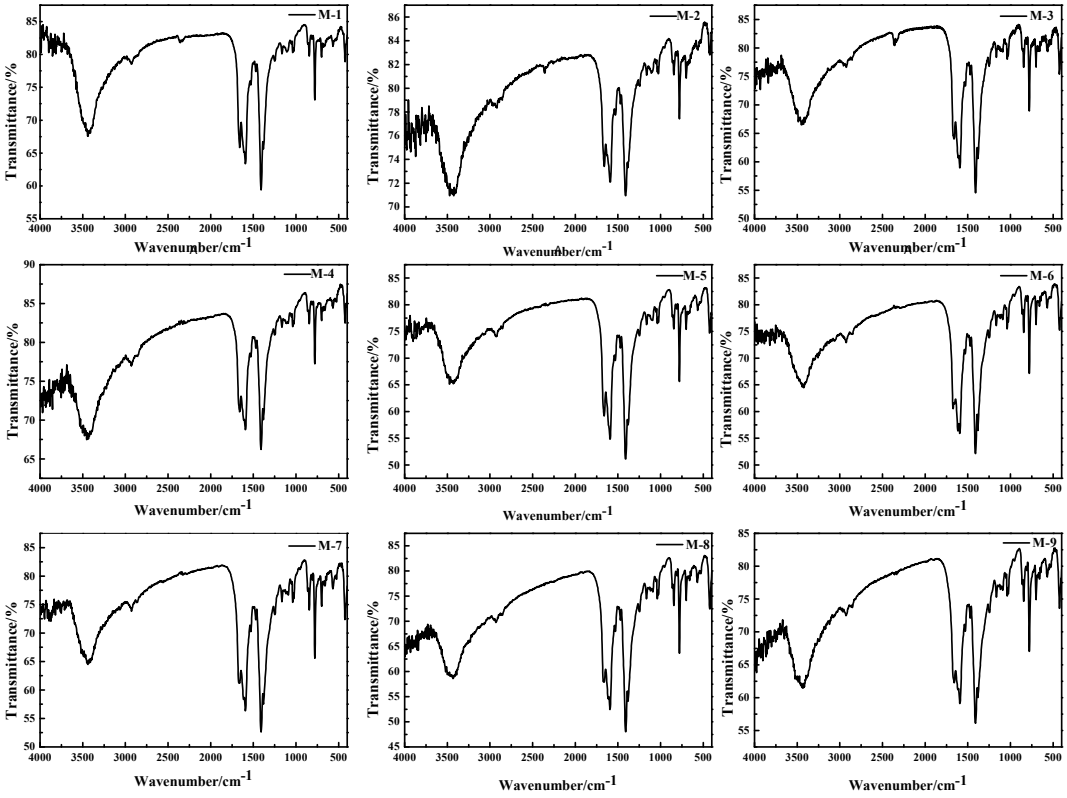



**Fig. S12** Infrared spectra of complex **M-1~M-9** recorded from a KBr pellet.

**Table S1.** Summary of the tunable color luminescent properties based on RGB primary colors.

| Empirical formula | Tunable color | Metal and Ligand | References |
|---|---|---|---|
| $[Eu(tta)_2(\mathbf{CR1})_2]_n$ | White | Eu<br>**CR1** = 7-diethylamino-2-oxo-2H-chromen-3-carboxylic chloride + N-(Rhodamine-6G)lactamethylenediamine<br>tta = 1,1,1-trifluoro-3-(2-thenoyl)acetone | Angew. Chem. Int. Ed. 2009, 48, 6132 –6135 |
| $Na_3[Ln(PDA)_3](H_2O)_x$<br>Ln = Eu (x = 10), Tb (x = 9) | White | Eu / Tb<br>PDA = pyridine-2,6-dicarboxylate | J. Mater. Chem., 2012, 22, 3210–3214 |
| $\{[EuOH(H_2O)_6][Zn_2Eu_4(4\text{-}Htbca)_2\text{-}(4\text{-}tbca)_8(H_2O)_{12}]\}_n \cdot 6nH_2O$<br>$\{[TbOH(H_2O)_6][Zn_2Tb_4(4\text{-}Htbca)_2\text{-}(4\text{-}tbca)_8(H_2O)_{12}]\}_n \cdot 6nH_2O$ | White | Gd / Tb / Eu<br>4-$H_2$tbca = 4-(1H-tetrazol-5-yl)-biphenyl-3-carboxylic acid | J. Mater. Chem. C, 2013, 1, 4634–4639 |
| $[H(H_2O)_8]$-$[LnZn_4(imdc)_4(Him)_4]$<br>[Ln = Eu (3), Gd (4), Tb (5)] | White | Gd / Tb / Eu<br>$H_3$imdc = 4,5-imidazoledicarboxylic acid;<br>Him = imidazole | Inorg. Chem. 2012, 51, 1201−1203 |
| $La(1,3,5\text{-}BTC)(H_2O)_6$:$Eu^{3+}$,$Tb^{3+}$ | White | Eu / Tb | Crystal Growth & Design, Vol. 10, No. 1, 2010, |

| | | | |
|---|---|---|---|
| | | 1,3,5-BTC = 1,3,5-benzenetricarboxylate | 16–19 |
| $\{[Ln_2(L)_2]\cdot(H_2O)_3\cdot(Me_2NH_2)_2\}_n$ (Ln = Eu (6), Gd (7), Tb (8)) | White | Gd / Tb / Eu<br>$H_4L$ = 5-(3,5-dicarboxybenzyloxy)-isophthalic acid | Dalton Trans., 2013, 42, 10579–10586 |
| $[Ln(dpdc)_{1.5}(IP)(H_2O)]_n$ (Ln = Eu 2, Gd 3) | White | Eu / Gd<br>dpdc = 2,2'-diphenyldicarboxylate and<br>IP = 1H-imidazo[4,5-f][1,10]-phenanthroline | Chem. Commun., 2013, **49**, 10397–10399 |
| $[Ln(TZI)\ (H_2O)_5]n$ [Ln = Eu (2), Gd (3), Tb (4)] | White | Gd / Tb / Eu<br>$H_3TZI$ = 5-(1H-tetrazol-5-yl)isophthalic acid | CrystEngComm, 2015, 17, 6030–6036 |
| $[NaLn\text{-}(pztc)(H_2O)_3]\cdot H_2O$ [Ln = Eu (3), Gd (4) and Tb (5)] | White | Gd / Eu / Tb<br>$H_4pztc$ = pyrazine-2,3,5,6-tetracarboxylic acid | Dalton Trans., 2014, 43, 12574–12581 |

**Table S2**. Selected bond distances (Å) and angles (°) for **1·Dy**.

| | | | | | |
|---|---|---|---|---|---|
| Dy(1)-O(1) | 2.301(3) | Dy(1)-O(8) | 2.412(3) | Dy(1)-O(7) | 2.533(3) |
| Dy(1)-O(3) | 2.306(3) | Dy(1)-O(4) | 2.471(4) | Dy(1)-N(2) | 2.547(3) |
| Dy(1)-O(7)#1 | 2.320(3) | Dy(1)-O(5) | 2.513(4) | Dy(1)-N(1) | 2.579(3) |
| | | | | | |
| O(1)-Dy(1)-O(3) | 138.59(10) | O(7)#1-Dy(1)-O(5) | 77.44(13) | O(8)-Dy(1)-N(2) | 75.63(12) |
| O(1)-Dy(1)-O(7)#1 | 75.30(11) | O(8)-Dy(1)-O(5) | 143.41(14) | O(4)-Dy(1)-N(2) | 92.11(14) |
| O(3)-Dy(1)-O(7)#1 | 75.21(11) | O(4)-Dy(1)-O(5) | 49.99(16) | O(5)-Dy(1)-N(2) | 70.33(13) |
| O(1)-Dy(1)-O(8) | 83.18(13) | O(1)-Dy(1)-O(7) | 72.30(11) | O(7)-Dy(1)-N(2) | 121.19(11) |
| O(3)-Dy(1)-O(8) | 91.69(13) | O(3)-Dy(1)-O(7) | 72.40(11) | O(1)-Dy(1)-N(1) | 137.77(12) |
| O(7)#1-Dy(1)-O(8) | 126.53(11) | O(7)#1-Dy(1)-O(7) | 74.89(11) | O(3)-Dy(1)-N(1) | 77.57(11) |
| O(1)-Dy(1)-O(4) | 125.73(14) | O(8)-Dy(1)-O(7) | 51.91(10) | O(7)#1-Dy(1)-N(1) | 146.60(12) |
| O(3)-Dy(1)-O(4) | 77.78(14) | O(4)-Dy(1)-O(7) | 146.16(13) | O(8)-Dy(1)-N(1) | 72.91(13) |
| O(7)#1-Dy(1)-O(4) | 82.42(14) | O(5)-Dy(1)-O(7) | 142.70(13) | O(4)-Dy(1)-N(1) | 73.17(14) |
| O(8)-Dy(1)-O(4) | 145.91(14) | O(1)-Dy(1)-N(2) | 77.53(11) | O(5)-Dy(1)-N(1) | 102.38(15) |
| O(1)-Dy(1)-O(5) | 76.86(15) | O(3)-Dy(1)-N(2) | 140.76(12) | O(7)-Dy(1)-N(1) | 114.50(11) |
| O(3)-Dy(1)-O(5) | 123.35(14) | O(7)#1-Dy(1)-N(2) | 141.62(12) | N(2)-Dy(1)-N(1) | 63.24(12) |

**Table S3**. Selected bond distances (Å) and angles (°) for **2·Dy**.

| | | | | | |
|---|---|---|---|---|---|
| Dy(1)-O(4)#1 | 2.4620(18) | Dy(1)-N(1) | 2.5169(18) | Dy(1)-O(2) | 2.557(2) |
| Dy(1)-O(4) | 2.4620(18) | Dy(1)-N(1)#1 | 2.5169(18) | Dy(1)-O(2)#1 | 2.557(2) |
| Dy(1)-O(1)#1 | 2.4676(16) | Dy(1)-N(2)#1 | 2.5243(17) | | |
| Dy(1)-O(1) | 2.4676(16) | Dy(1)-N(2) | 2.5243(17) | | |
| O(4)#1-Dy(1)-O(4) | 51.97(10) | O(4)#1-Dy(1)-N(2) | 82.64(7) | O(1)#1-Dy(1)-O(2)#1 | 50.65(6) |
| O(4)#1-Dy(1)-O(1)#1 | 70.25(6) | O(4)-Dy(1)-N(2) | 128.94(7) | O(1)-Dy(1)-O(2)#1 | 124.74(6) |
| O(4)-Dy(1)-O(1)#1 | 73.07(6) | O(1)#1-Dy(1)-N(2) | 69.99(6) | N(1)#1-Dy(1)-O(2)#1 | 120.93(6) |
| O(4)#1-Dy(1)-O(1) | 73.07(6) | O(1)-Dy(1)-N(2) | 122.47(6) | N(1)-Dy(1)-O(2)#1 | 68.49(6) |
| O(4)-Dy(1)-O(1) | 70.25(6) | N(1)#1-Dy(1)-N(2) | 89.15(6) | N(2)-Dy(1)-O(2)#1 | 111.20(6) |
| O(1)#1-Dy(1)-O(1) | 139.04(9) | N(1)-Dy(1)-N(2) | 64.38(6) | N(2)#1-Dy(1)-O(2)#1 | 71.91(6) |
| O(4)#1-Dy(1)-N(1)#1 | 134.57(7) | O(4)#1-Dy(1)-N(2)#1 | 128.93(7) | O(4)#1-Dy(1)-O(2) | 66.48(7) |
| O(4)-Dy(1)-N(1)#1 | 138.00(6) | O(4)-Dy(1)-N(2)#1 | 82.64(7) | O(4)-Dy(1)-O(2) | 103.55(7) |
| O(1)#1-Dy(1)-N(1)#1 | 146.45(6) | O(1)#1-Dy(1)-N(2)#1 | 122.47(6) | O(1)#1-Dy(1)-O(2) | 124.75(6) |
| O(1)-Dy(1)-N(1)#1 | 74.28(6) | O(1)-Dy(1)-N(2)#1 | 69.99(6) | O(1)-Dy(1)-O(2) | 50.65(6) |
| O(4)#1-Dy(1)-N(1) | 138.01(6) | N(1)#1-Dy(1)-N(2)#1 | 64.37(6) | N(1)#1-Dy(1)-O(2) | 68.49(6) |
| O(4)-Dy(1)-N(1) | 134.57(7) | N(1)-Dy(1)-N(2)#1 | 89.15(6) | N(1)-Dy(1)-O(2) | 120.93(6) |
| O(1)#1-Dy(1)-N(1) | 74.28(6) | N(2)-Dy(1)-N(2)#1 | 147.68(9) | N(2)-Dy(1)-O(2) | 71.91(6) |
| O(1)-Dy(1)-N(1) | 146.45(6) | O(4)#1-Dy(1)-O(2)#1 | 103.55(7) | N(2)#1-Dy(1)-O(2) | 111.19(6) |
| N(1)#1-Dy(1)-N(1) | 73.02(9) | O(4)-Dy(1)-O(2)#1 | 66.48(7) | O(2)#1-Dy(1)-O(2) | 169.48(9) |

**Table S4**. Selected bond distances (Å) and angles (°) for **3·Dy**.

| | | | | | |
|---|---|---|---|---|---|
| Dy(1)-O(1) | 2.301(3) | Dy(1)-O(8) | 2.412(3) | Dy(1)-O(4) | 2.471(4) |
| Dy(1)-O(5) | 2.513(4) | Dy(1)-O(7) | 2.533(3) | Dy(1)-N(2) | 2.547(3) |
| Dy(1)-O(3)#1 | 2.306(3) | Dy(1)-O(7)#1 | 2.320(3) | Dy(1)-N(1) | 2.579(3) |
| O(1)-Dy(1)-O(3)#1 | 138.59(10) | O(1)-Dy(1)-O(7)#1 | 75.30(11) | O(3)#1-Dy(1)-O(7)#1 | 75.21(11) |
| O(1)-Dy(1)-O(8) | 83.18(13) | O(3)#1-Dy(1)-O(8) | 91.69(13) | O(7)#1-Dy(1)-O(8) | 126.53(11) |
| O(1)-Dy(1)-O(4) | 125.73(14) | O(3)#1-Dy(1)-O(4) | 77.78(14) | O(7)#1-Dy(1)-O(4) | 82.42(14) |
| O(8)-Dy(1)-O(4) | 145.91(14) | O(1)-Dy(1)-O(5) | 76.86(15) | O(3)#1-Dy(1)-O(5) | 123.35(14) |
| O(7)#1-Dy(1)-O(5) | 77.44(13) | O(8)-Dy(1)-O(5) | 143.41(14) | O(4)-Dy(1)-O(5) | 49.99(16) |
| O(1)-Dy(1)-O(7) | 72.30(11) | O(3)#1-Dy(1)-O(7) | 72.40(11) | O(7)#1-Dy(1)-O(7) | 74.89(11) |
| O(8)-Dy(1)-O(7) | 51.91(10) | O(4)-Dy(1)-O(7) | 146.16(13) | O(5)#1-Dy(1)-N(1) | 142.70(13) |
| O(1)-Dy(1)-N(2) | 77.53(11) | O(3)#1-Dy(1)-N(2) | 140.76(12) | O(7)#1-Dy(1)-N(2) | 141.62(12) |
| O(8)-Dy(1)-N(2) | 75.63(12) | O(4)-Dy(1)-N(2) | 92.11(14) | O(5)-Dy(1)-N(2) | 70.33(13) |
| O(7)-Dy(1)-N(2) | 121.19(11) | O(1)-Dy(1)-N(1) | 137.77(12) | O(3)#1-Dy(1)-N(1) | 77.57(11) |
| O(7)#1-Dy(1)-N(1) | 146.60(12) | O(8)-Dy(1)-N(1) | 72.91(13) | O(4)-Dy(1)-N(1) | 73.17(14) |
| O(5)-Dy(1)-N(1) | 102.38(15) | O(7)-Dy(1)-N(1) | 114.50(11) | N(2)-Dy(1)-N(1) | 63.24(12) |