S1. Quantitative formulas to describe temperature-dependent luminescence

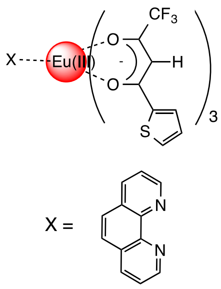
The luminescence lifetime is expressed as follows.[1]

$$\tau = \frac{1}{k_r + k_{nr}}$$

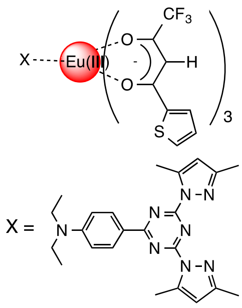
k_{nr} is related to T via the Arrhenius equation.

$$k_{nr} \sim e^{(-\Delta E/kT)}$$

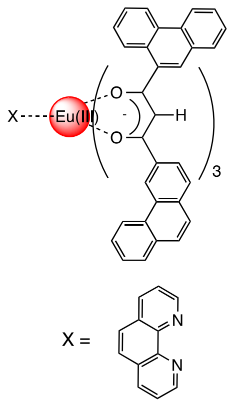
where ΔE is the energy gap between the lowest level of the excited state and the overlap point to a possible non-radiative decay state. In many cases of lanthanide(III) complexes, the non-radiative decay states corresponding to the T_1 states of organic ligands. The equations of temperature-dependent luminescence intensity of lanthanide(III) complexes have also been reported.



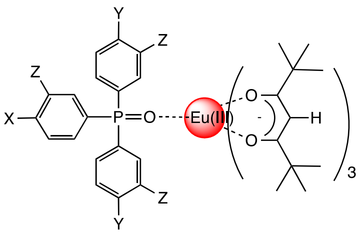
Compound (1)



Compound (2)



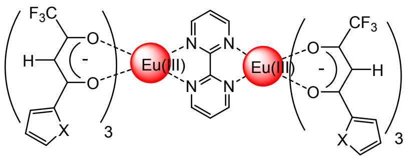
Compound (3)



$X = CH_3, Y = Z = H$ — Compound (4)

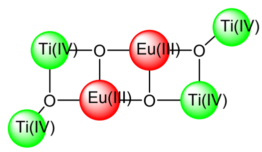
$X = Y = CH_3, Z = H$ — Compound (5)

$X = Y = H, Z = CH_3$ — Compound (6)

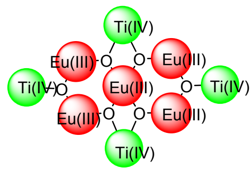


X = O — Compound (7)

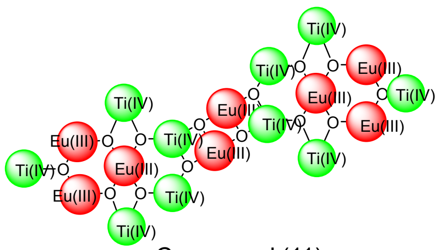
X = S — Compound (8)



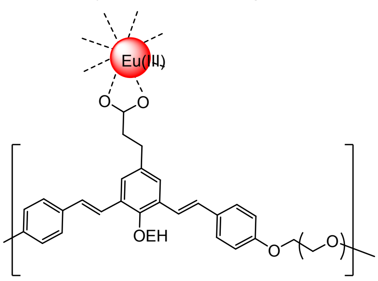
Compound (9)
(Ligand: 4-tert-butyl-benzoate)



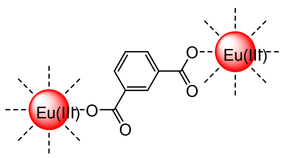
Compound (10)
(Ligand: 4-tert-butyl-benzoate)



Compound (11)
(Ligand: 4-tert-butyl-benzoate)



Compound (12)



Compound (13)

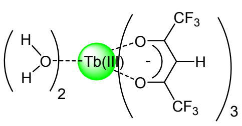
S2. Temperature-dependent photophysical properties of Ln(III) compounds

Fig. S1 Eu(III) compounds

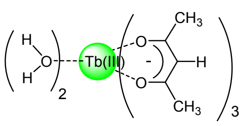
Table S1 Temperature-dependent photophysical data of Eu(III) compounds

Fig. S1	medium	$\Phi_{\pi\pi}$/ %	TR	Sensitivity	Ref
1	Toluene	-	273K-373K	-	95
2	LB	-	290K-370K	-	98
3	PViCl	-	278K-333K	4.42 %/ ^{o}C	96
4	(SS)	0.5 (82.0)	300K-420K	-	107
5	(SS)	0.6 (85.0)	300K-420K	-	107
6	(SS)	0.6 (86.0)	300K-420K	-	107
7	Toluene	-	273K-333K	-	123
8	Toluene	-	273K-333K	-	123
9	Toluene	7.05	-	-	124
	(SS)	17.6	100K-300K	0.36 % / K	
10	Toluene	29.6	-	-	124
	(SS)	94.9	100K-300K	0.31 % / K	
11	Toluene	45.3	-	-	124
	(SS)	73.1	100K-300K	0.74 % / K	
12	CB	13-27	293K-373K	1.5-1.6 % / K	136
13	(SS)	(22.7)	77K, 298K	-	135

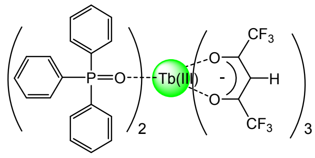
LB: LB film mixed with poly-(N-dodecylacrylamide), PViCl: Poly(vinylidene chloride-co-acrylonitrile), SS: Solid state, TR: temperature range, CB: Chlorobenzene, $\Phi_{\pi\pi}$ is emission quantum yield excited by ligands. Value in brackets ($\Phi_{\pi\pi}$) is emission quantum yield excited by lanthanide ions.



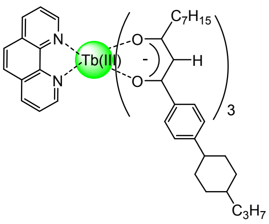
Compound (1)



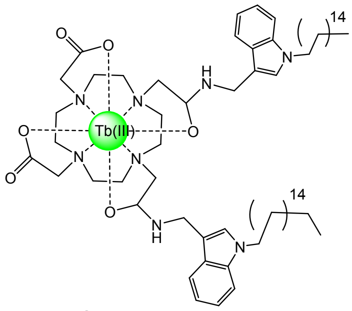
Compound (2)



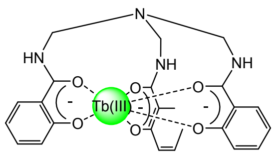
Compound (3)



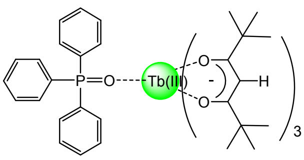
Compound (4)



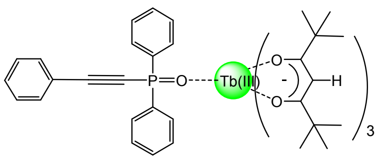
Compound (5)



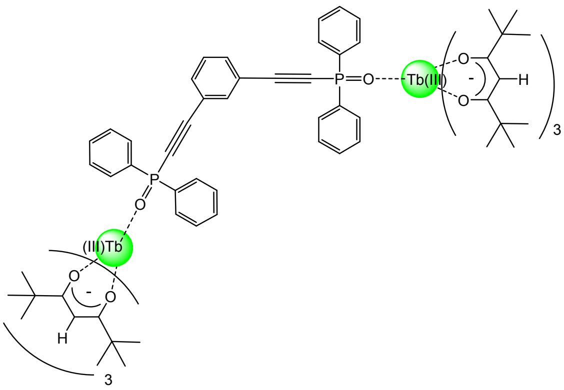
Compound (6)



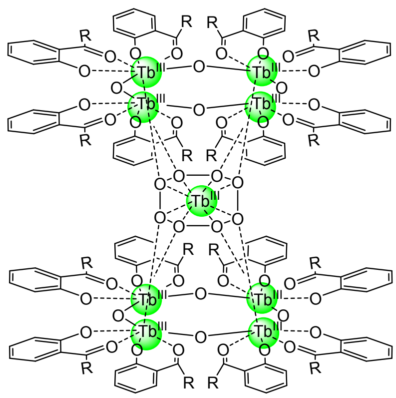
Compound (7)



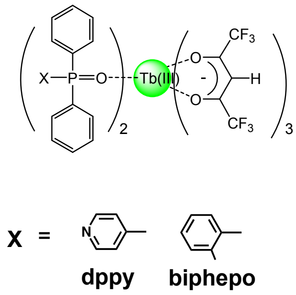
Compound (8)



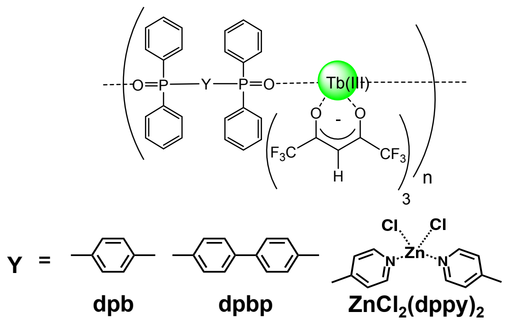
Compound (9)



Compound (10)



Compound (11), (12)



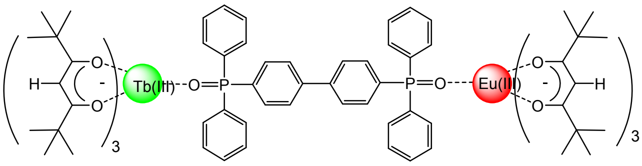
Compound (13), (14), (15)

Fig. S2 Tb(III) compounds

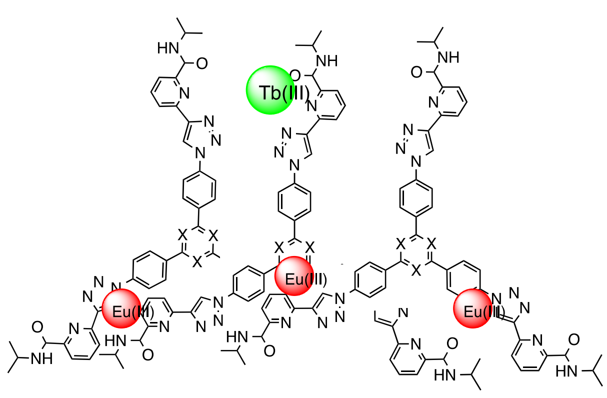
Table S2 Temperature-dependent photophysical data of Tb(III) compounds

Fig. S2	medium	$\Phi_{\pi\pi}$/ %	TR	Sensitivity	Ref
1	acetone-d_6	(1.7)	283K-323K	1.81 %/ ^{o}C	109
2	acetone-d_6	(59)	283K-323K	0.45 %/ ^{o}C	109
3	acetone-d_6	(30)	283K-323K	1.90 %/ ^{o}C	109
	(SS)	9.2	150K-400K		165
4	(Film)	-	143K-253K	3.3 μs/ K	112
5	BA	-	273K-298K	-	113
6	PVA	22	293K-338K	3.80 %/ ^{o}C	114
7	(SS)	66	-	-	115
8	(SS)	71	340K-400K	-	115
9	(SS)	39	340K-400K	-	115
10	(SS)	2.4-31	240K-360K	-	126
11	(SS)	10	150K-400K	-	165
12	(SS)	11	150K-400K	-	165
13	(SS)	9.7	150K-400K	-	165
14	(SS)	17	150K-400K	-	165
16	(SS)	35	150K-400K	-	165

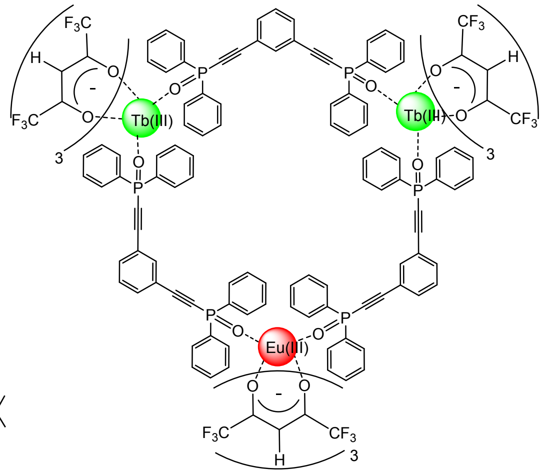
BA: buffered aqueous solution, PVA: Poly(vinyl alcohol), SS: Solid state, TR: temperature range, $\Phi_{\pi\pi}$ is emission quantum yield excited by ligands. Value in brackets ($\Phi_{\pi\pi}$) is emission quantum yield excited by lanthanide ions.



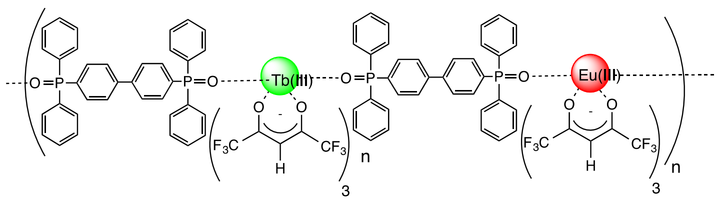
Compound (1)



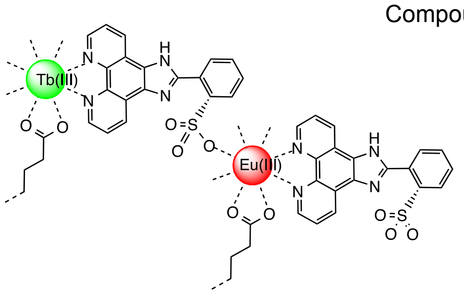
Compound (2)



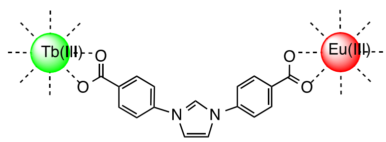
Compound (3)



Compound (4)



Compound (5)



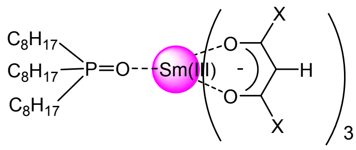
Compound (6)

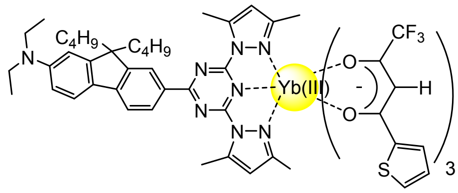
Fig. S3 Eu(III)-Tb(III) compounds

Table S3 Temperature-dependent photophysical data of Eu-Tb(III) compounds

Fig. S3	medium	$\Phi_{\pi\pi}$/ %	TR	Sensitivity	Ref
1	(SS)	-	100K-450K	2.2 %/ K	128
2	(SS)	-	200K-360K	1.52 %/ K	129
3	(Film)	-	100K-400K	0.92 %/ K	140
4	(SS)	-	200K-450K	0.83 %/ ^{o}C	139
5	(SS)	-	50K-225K	0.68 %/ K	148
6	(SS)	-	40K-300K	0.11-0.17 %/ K	155

SS: Solid state, TR: temperature range, $\Phi_{\pi\pi}$ is emission quantum yield excited by ligands.

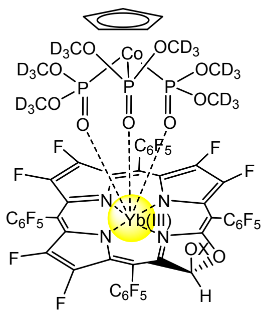


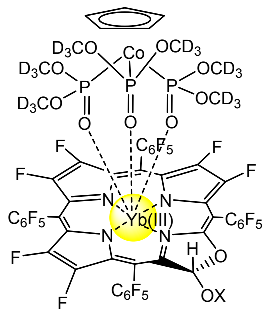


X = CH_3 X = CF_3

Compound (1) Compound (2)

Compound (3)



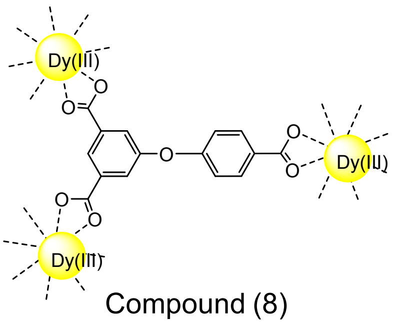


X = D X = CD_3

Compound (4) Compound (5)

X = D X = CD_3

Compound (6) Compound (7)



Figur

Compound (8)

e S4. Sm(III), Yb(III) and Dy(III) compounds.

Table S4 Temperature-dependent photophysical data of Sm(III), Yb(III) and Dy(III) compounds.

Fig. S4	medium	$\Phi_{\pi\pi}$/ %	TR	Sensitivity	Ref
1	HTPB	-	293K-423K	1.26 %/ K	119
2	HTPB	-	200K-383K	1.37 %/ K	119
3	PMMA	0.9	178K-378K	-	121
4	MG	6.2	77K-400K	6.0 %/ ^{o}C	122
5	MG	9.1	-	-	122
6	MG	6.8	77K-400K	3.8 %/ ^{o}C	122
7	MG	9.2	-	-	122
8	(SS)	-	298K-473K	-	137

HTPB: hydroxyl-terminated polybutadiene, PMMA: Polymethyl methacrylate, MG: methanol/glycerol mixtures, SS: solid state, $\Phi_{\pi\pi}$ is emission quantum yield excited by ligands.