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Supplementary Materials

Europium(III) Complex-Functionalized SiO_2@mTiO_2 Nanospheres for Al^{3+}-Modulated Multicolor Emission

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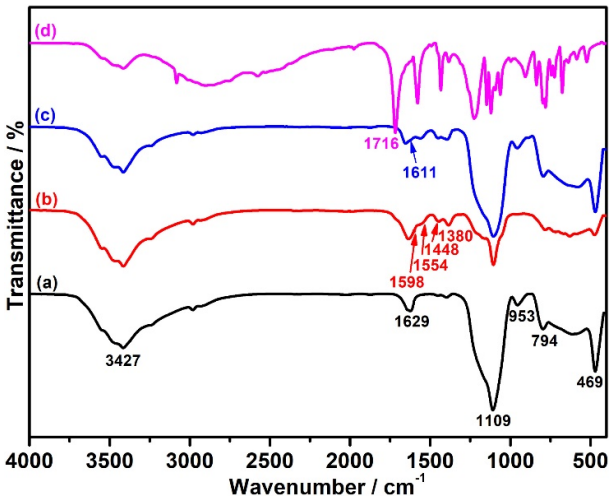

Figure S1. FT-IR spectra of SiO_2@mTiO_2 (a), SiO_2@mTiO_2-bpdc (b), Eu(tta)$_3$bpdc-SiO_2@mTiO_2 (c) and H_2bpdc ligand (d).

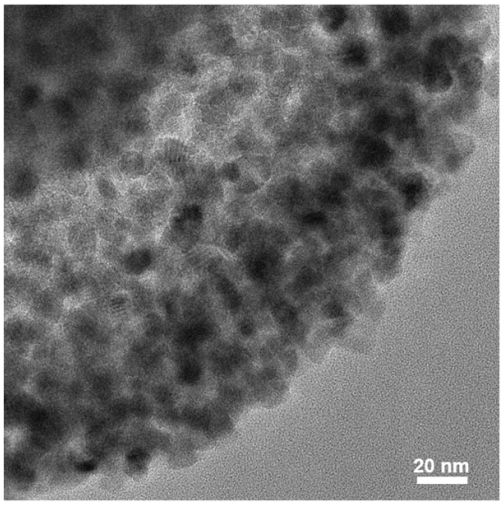

Figure S2. TEM image of SiO_2@mTiO_2.

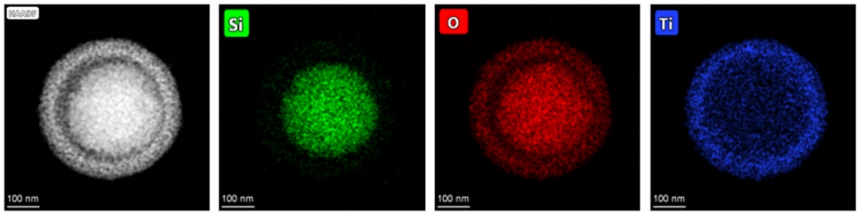

Figure S3. EDS mapping for each element in SiO_2@mTiO_2.

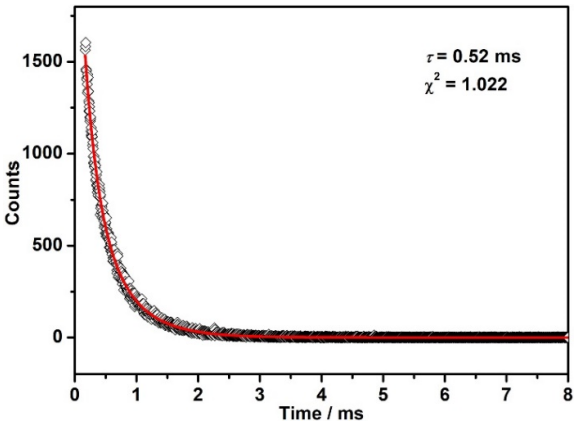

Figure S4. Luminescent lifetime of hybrid material Eu(tta)$_3$bpdc-SiO$_2$@mTiO$_2$ in state solid.

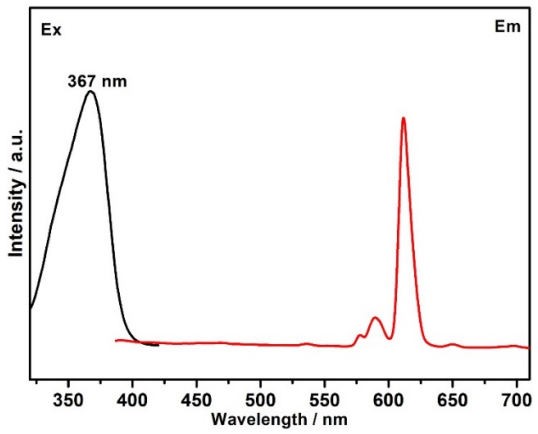

Figure S5. Excitation and emission spectra of hybrid material Eu(tta)$_3$bpdc-SiO$_2$@mTiO$_2$ in ethanol solution at room temperature.

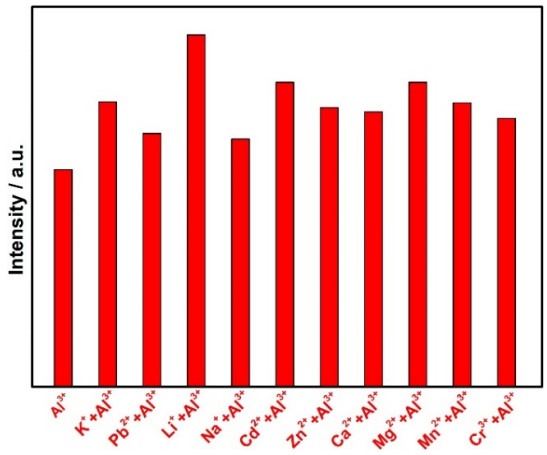

Figure S6. Luminescent intensities of hybrid material Eu(tta)$_3$bpdc-SiO$_2$@mTiO$_2$ at 396 nm in presence of other metal ions and Al^{3+} ion in ethanol solution.

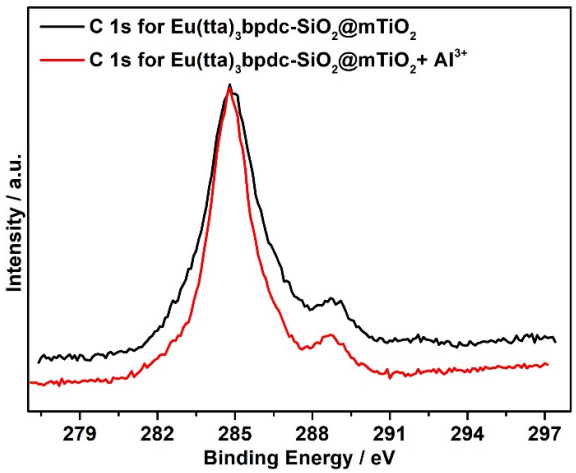

Figure S7. C 1s spectra for hybrid materials Eu(tta)$_3$bpdc-SiO$_2$@mTiO$_2$ and Eu(tta)$_3$bpdc-SiO$_2$@mTiO$_2$ + Al^{3+}.

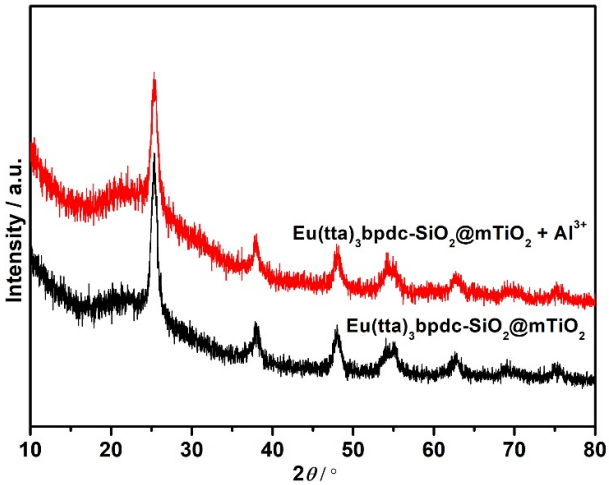

Figure S8. The PXRD patterns of hybrid materials Eu(tta)$_3$bpdc-SiO$_2$@mTiO$_2$ and Eu(tta)$_3$bpdc-SiO$_2$@mTiO$_2$ + Al^{3+}.

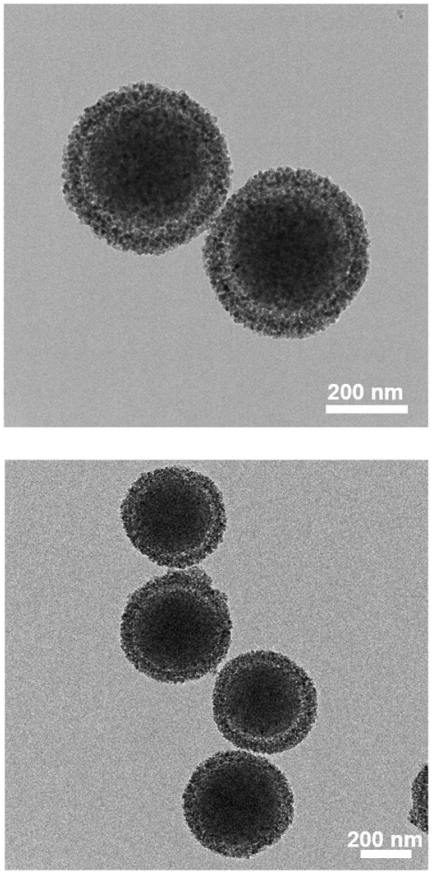

Figure S9. TEM image of $Eu(tta)_3bpdc\text{-}SiO_2@mTiO_2 + Al^{3+}$.

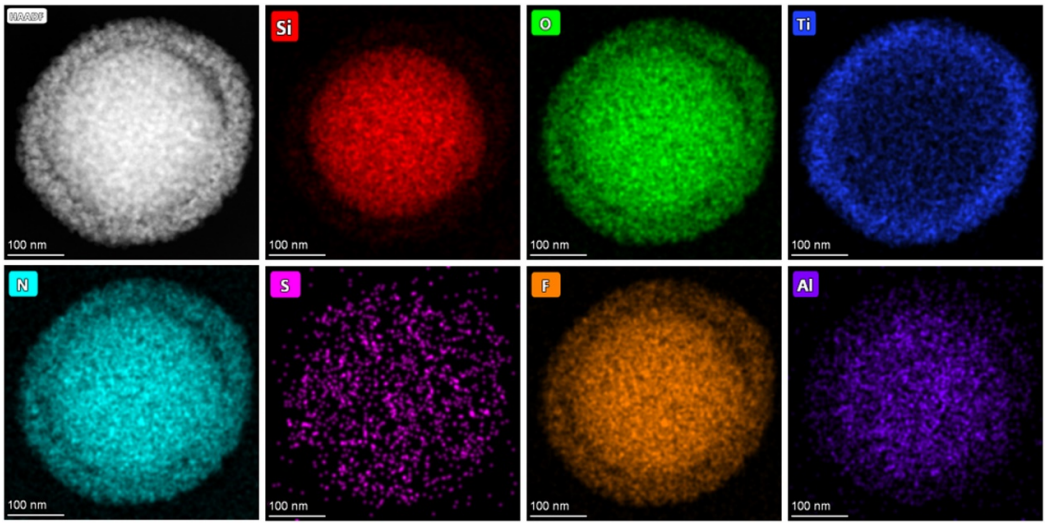

Figure S10. EDS mapping for each element in $Eu(tta)_3bpdc\text{-}SiO_2@mTiO_2 + Al^{3+}$.

Table S1. The FT-IR characteristic bands of SiO_2@mTiO_2, SiO_2@mTiO_2-bpdc, Eu(tta)$_3$bpdc-SiO_2@mTiO_2 and H_2bpdc ligand.

Characteristic Bands	Wavenumber / cm^{-1}	Ref.
Ti–O	450~750	[1]
Si–O asymmetric stretching vibration	1109	[2,3]
Si–O symmetric stretching vibration	794	[2,3]
Si–OH stretching vibration	953	[2,3]
carboxylic groups of H_2bpdc	1716	[1]
$\nu_{asym}(COO^-)$ of SiO_2@mTiO_2-bpdc	1554	[1,4–8]
$\nu_{sym}(COO^-)$ of SiO_2@mTiO_2-bpdc	1380	[1,4–8]
C=N of SiO_2@mTiO_2-bpdc	1598	[1]
C=N of Eu(tta)$_3$bpdc-SiO_2@mTiO_2	1611	[1]

Table S2. The characteristic diffraction peaks for PXRD in SiO_2@mTiO_2, SiO_2@mTiO_2-bpdc, Eu(tta)$_3$bpdc-SiO_2@mTiO_2 and Eu(tta)$_3$bpdc-SiO_2@mTiO_2 + Al^{3+}.

	SiO_2@mTiO_2	SiO_2@mTiO_2-bpdc	Eu(tta)$_3$bpdc-SiO_2@mTiO_2	Eu(tta)$_3$bpdc-SiO_2@mTiO_2 + Al^{3+}
(101)	25.27°	25.30°	25.33°	25.31°
(004)	37.84°	37.84°	37.84°	37.81°
(200)	48.03°	48.01°	48.01°	48.10°
(105)	54.23°	54.29°	54.30°	54.31°
(211)	55.04°	55.03°	55.03°	55.05°
(204)	62.64°	62.63°	62.62°	62.61°
(116)	69.32°	69.33°	62.34°	62.34°
(220)	71.29°	71.29°	71.29°	71.29°
(215)	75.63°	75.66°	75.66°	75.66°

Table S3. CIE coordinates and emission colors of hybrid material $Eu(tta)_3bpdc\text{-}SiO_2@mTiO_2$ in different concentrations of Al^{3+} ion.

Concentration of Al^{3+} ion (μM)	CIE (x, y)	Color
0	(0.565, 0.325)	Red
16	(0.454, 0.279)	Pink
33	(0.356, 0.231)	Pink
49	(0.303, 0.199)	Pink
66	(0.269, 0.177)	Pink
82	(0.245, 0.162)	Purplish pink
99	(0.227, 0.148)	Purplish pink
115	(0.210, 0.133)	Purplish pink
147	(0.193, 0.116)	Purplish blue
180	(0.183, 0.105)	Purplish blue
212	(0.177, 0.097)	Purplish blue
243	(0.175, 0.094)	Blue

Table S4. Binding energies for XPS in hybrid materials $Eu(tta)_3bpdc\text{-}SiO_2@mTiO_2$ and $Eu(tta)_3bpdc\text{-}SiO_2@mTiO_2 + Al^{3+}$.

Peak	$Eu(tta)_3bpdc\text{-}SiO_2@mTiO_2$	$Eu(tta)_3bpdc\text{-}SiO_2@mTiO_2+Al^{3+}$
C 1s	284.8	284.8
O 1s	529.8	529.8
N 1s	398.8	398.8
F 1s	687.8	685.8
Si 2p	102.8	102.8
Ti 2p	458.8	457.8
S 2p	164.8	164.8
Eu 3d	1138.4	------
Al 2p	------	74.8

Table S5. The mass ratio of each element in $Eu(tta)_3bpdc\text{-}SiO_2@mTiO_2$ and $Eu(tta)_3bpdc\text{-}SiO_2@mTiO_2 + Al^{3+}$.

Elements	Line	Weight / %	
		$Eu(tta)_3bpdc\text{-}SiO_2@mTiO_2$	**$Eu(tta)_3bpdc\text{-}SiO_2@mTiO_2 + Al^{3+}$**
Si	Kα	22.00	21.35
O	Kα	44.79	43.73
Ti	Kα	18.12	17.10
C	Kα	7.16	7.04
N	Kα	4.64	4.38
F	Kα	0.24	0.17
Eu	Lα	3.05	0.32
Al	Lα	----	5.91

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