This ESI replaces the original version published on 18 Jan 2023.

Supporting information

Design of $Eu(TTA)_3$phen-incorporated SiO_2-coated iron oxide nanoparticles for efficient luminescence and magnetic performance

Yun-Kun Hong[a], Hyun Tae Kim[a], Yoonsu Park[a], Wooseok Jeong[a], Minyoung Kim[a], Eunseo Hwang[a], Yun Jae Hwang[a], Min-Ho Lee[a], and Don-Hyung Ha[a,*]

School of Integrative Engineering, Chung-Ang University, 84 Heukseok-ro, Dongjak-gu, Seoul, 06974, Republic of Korea

* To whom correspondence should be addressed.

Email: dhha@cau.ac.kr (D.-H. Ha), Phone: +82-2-820-5565

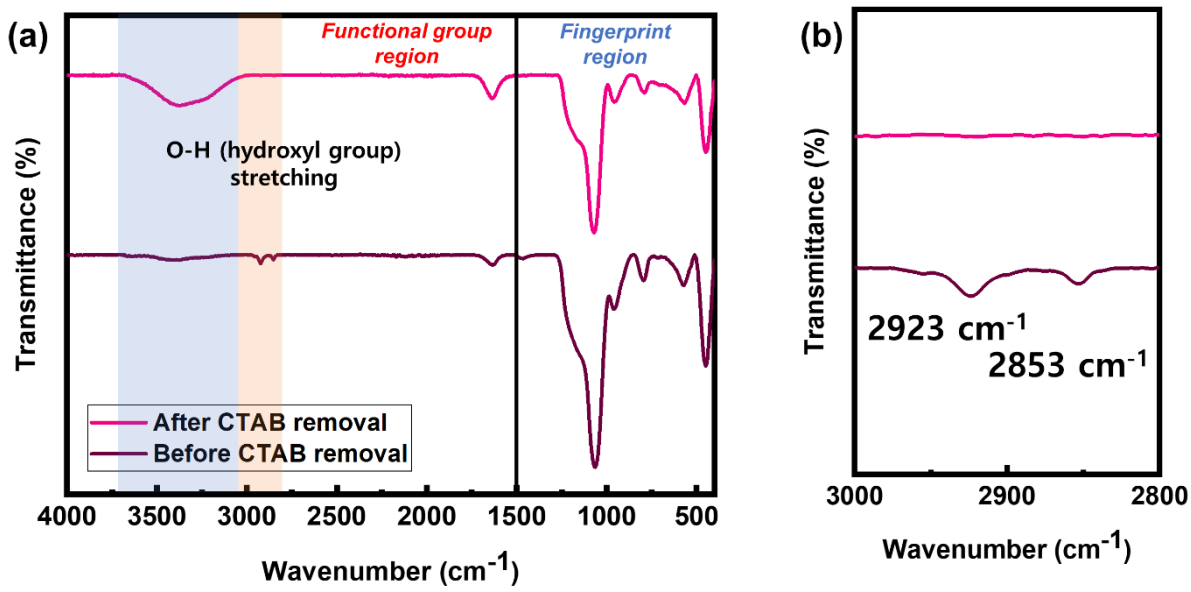


Figure S1. Composition of the functional group in SIOPs with and w/o CTAB removal treatments. (a) the absorption peak at 1500–100 cm^{-1} corresponds to the symmetric and asymmetric stretching vibration of the frameworks and the Si–O–Si vibration, which confirmed the uniform coating of the IONPs by the silica layer. (b) The bands at approximately 3000 cm^{-1} are assigned to the CTAB was removed by HCl treatment.

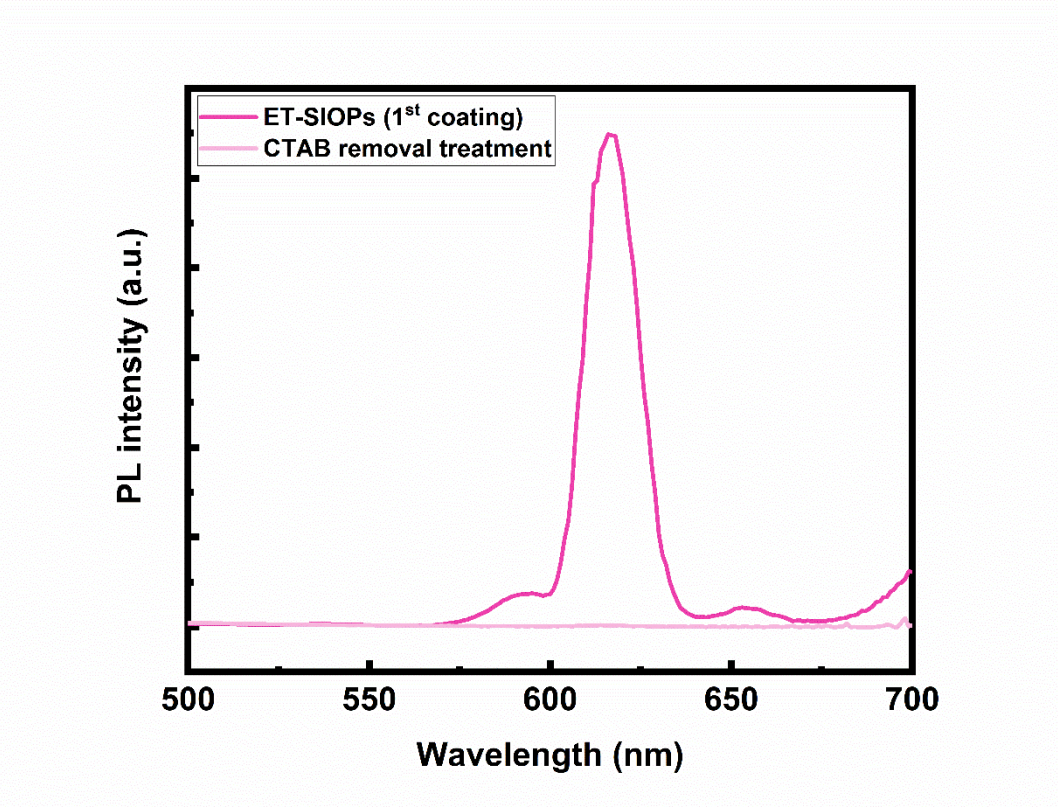


Figure S2. Emission spectra of $Eu(TTA)_3$phen-incorporated SiO_2-coated iron oxide nanoparticles (ET-SIOPs; 1st coating). The luminescent property of ET-SIOPs disappeared after the CTAB removal treatment conducted using HCl at 60 °C for 3 h.

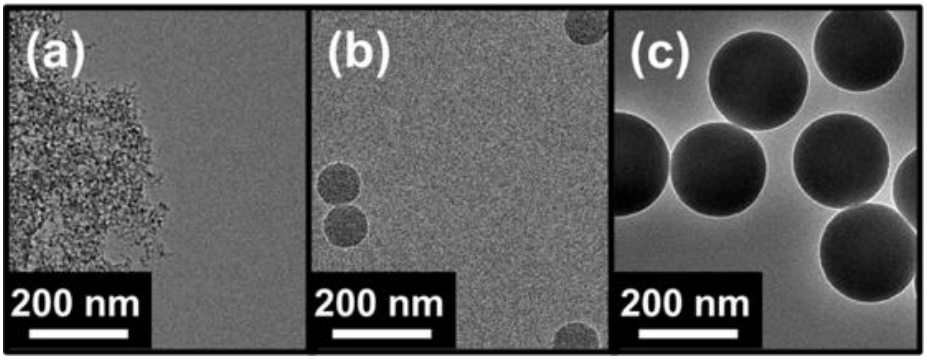


Figure S3. TEM images of Eu-SIOPs using various Eu precursors (a) EN, (b) EO, and (c) ET.

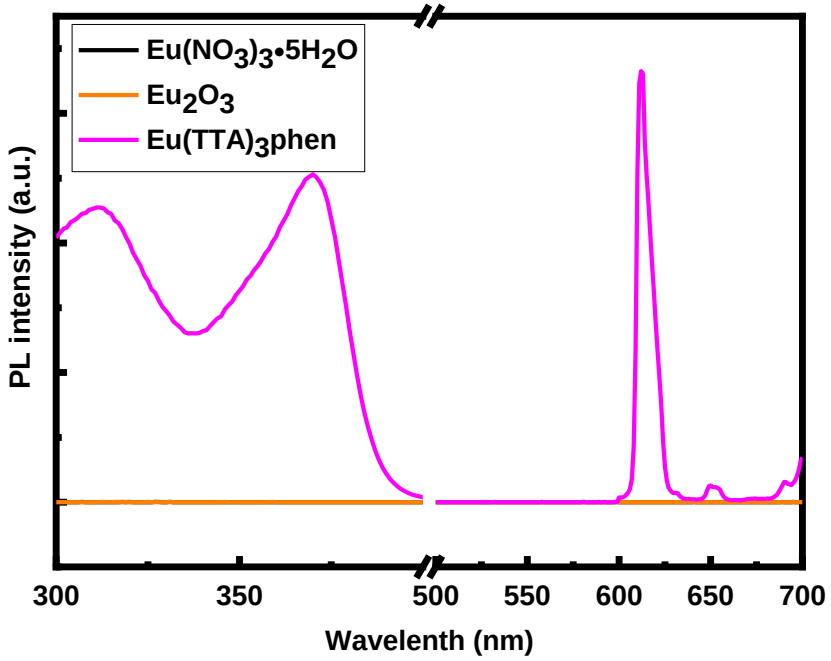


Figure S4. Photophysical property of Eu-SiO_2 NPs synthesized with various Eu precursors, including EN, EO, and ET.

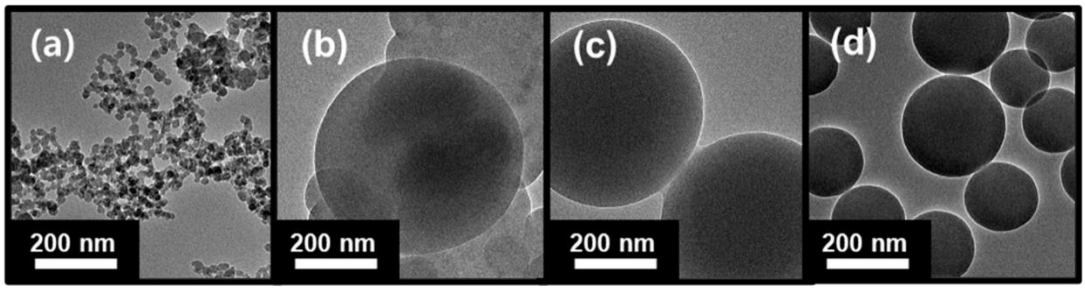


Figure S5. Effect of the NH_3 concentration for evolution of Si NPs synthesized with 1 mL of ET solution (10 mg/mL). (a) $[NH_4OH]$ = 0.25 M, (b) $[NH_4OH]$ = 0.73 M (c) $[NH_4OH]$ = 0.95 M (d) $[NH_4OH]$ = 1.17 M.

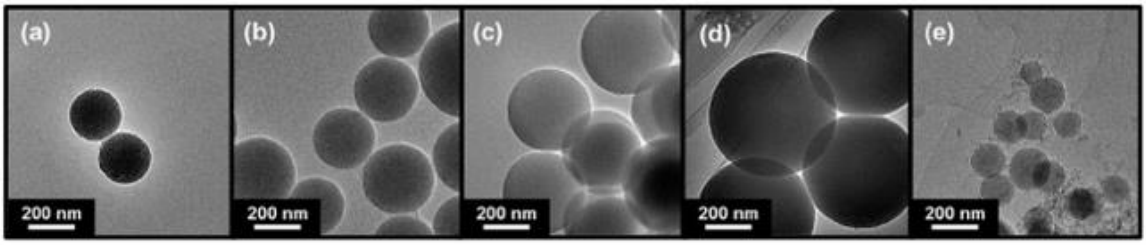


Figure S6. Change in the particle size of Eu-SIOPs with a change in the reaction temperature. (a) 25 ℃, (b) 35 ℃, (c) 45 ℃, (d) 65 ℃, and (e) 90 ℃.

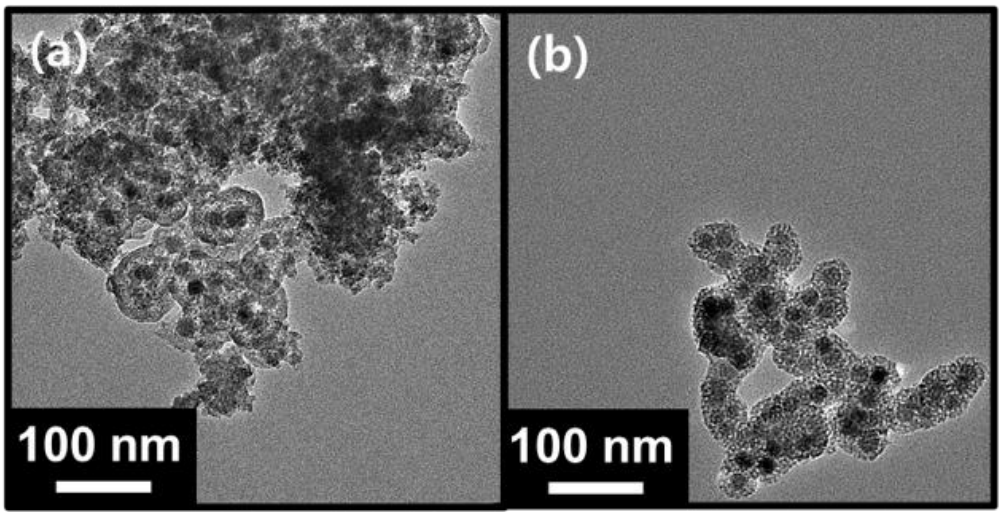
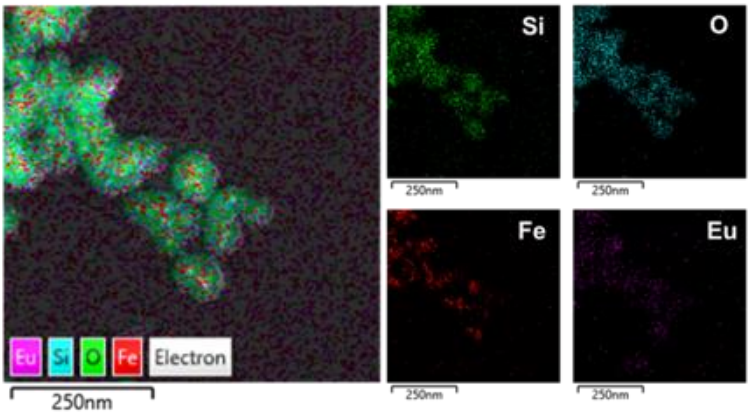


Figure S7. Morphology of (a) EN-SIOPs and (b) EO-SIOPs.



Sample \ Atomic%	O	Si	Fe	Eu
2 h ET-SIOPs	71.63	21.7	4.31	2.36

Figure S8. Elemental mapping of the ET-SIOPs. Aqua, green, red, and violet represent silica, oxygen, iron, and europium distributions, respectively.

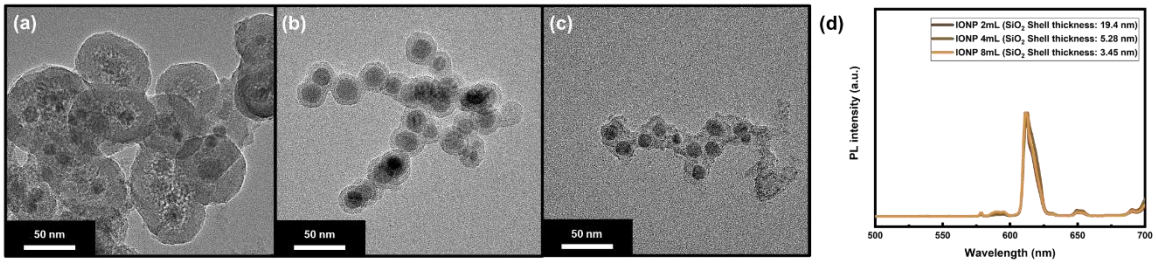


Figure S9. The control of SiO_2 shell thickness on iron oxide nanoparticle. The SiO_2 shell thickness was easily controlled by the amount of IONPs. (a) 2 mL of IONPs (SiO2 shell thickness: 19.4 nm). (b) 4 mL of IONPs (SiO_2 shell thickness: 5.3 nm), (c) 8 mL of IONPs (SiO_2 shell thickness: 3.5 nm). (d) the emission spectra of ET-SIOPs synthesized by controlling the shell thickness.

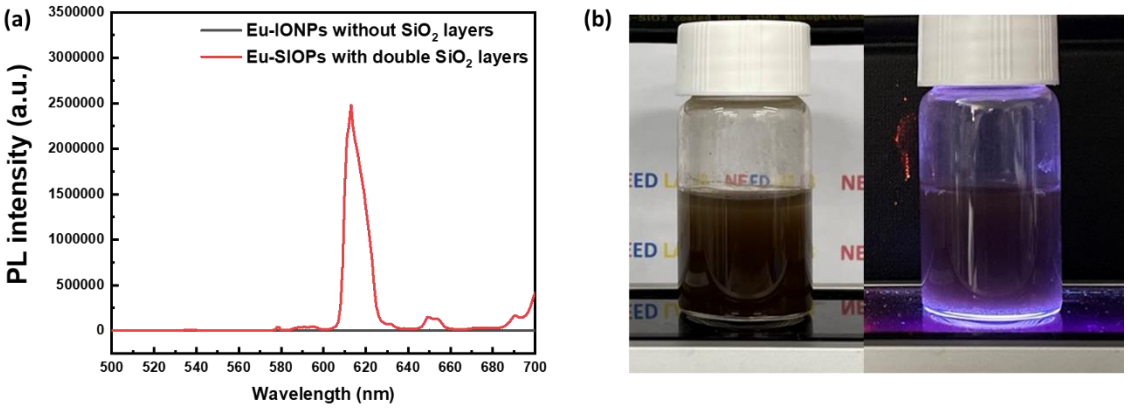


Figure S10. Photo-physical analysis with Eu-incorporated IONPs (Eu-IONPs) without double SiO_2 layers and Eu-incorporated SIOPs (Eu-SIOPs) with double SiO_2 layers. (a) Emission spectra of Eu-IONPs without first SiO_2 layer and Eu-SIOPs with first SiO_2 layer. (b) Photo images of Eu-IONPs without first SiO_2 layer (left: visible light, right: under UV-irradiation 365 nm)

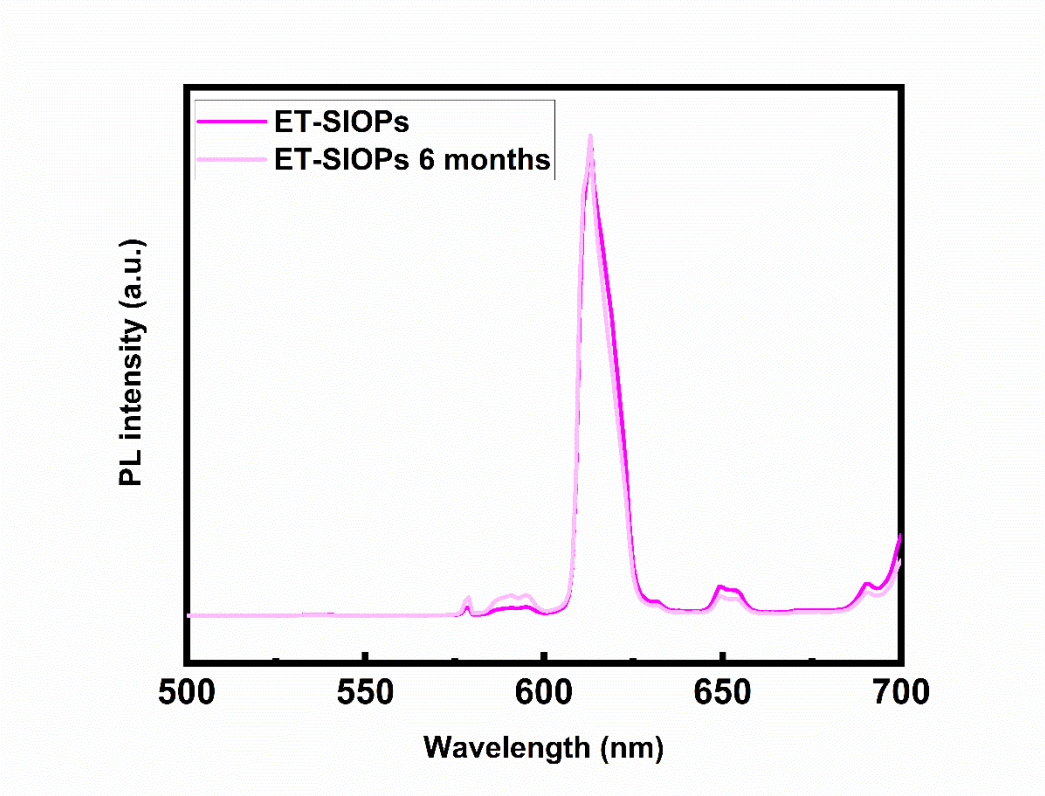


Figure S11. Luminescence stability of the ET-SIOPs. The emission property of ET-SIOPs was maintained for 6 months.

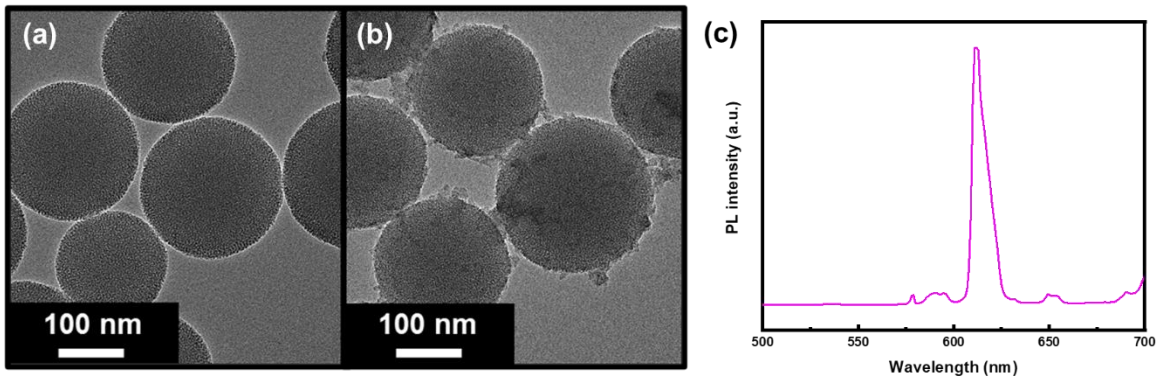


Figure S12. (a), (b) morphology of SiO_2 NPs and Eu incorporated SiO_2 NPs. (c) photophysical property of Eu incorporated SiO_2 NPs synthesized with ET.

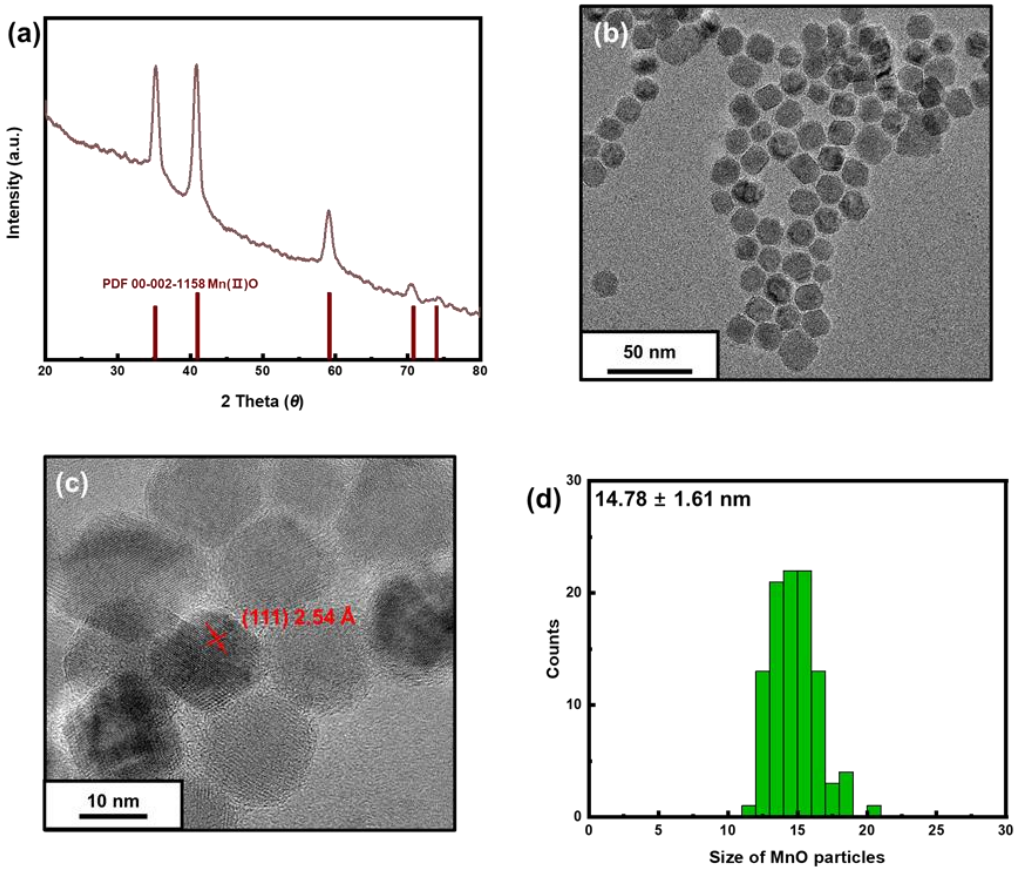


Figure S13. Characteristic results of Mn(II)O NPs synthesized with Mn-oleate, octyl ether, and oleic acid at 280 ºC for 2h. (a) the XRD spectrum of manganese oxide.

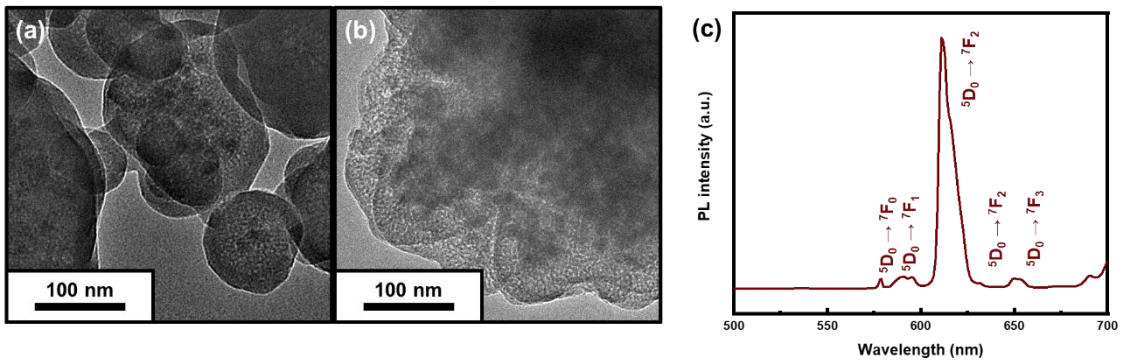


Figure S14. (a), (b) morphology of SiO_2 coated- and Eu incorporated SiO_2-MnO NPs. (c) photophysical property of Eu incorporated SiO_2-MnO NPs synthesized with ET.

Table S1. The condition of silica layer coating on different sizes of IONPs.

Fe_3O_4 NPs (6.7 mg/mL)	Sonication time	CTAB (0.055 mM)	D.W	NH_4OH (28%)	TEOS	Ethyl acetate
4 mL	30 min	5 mL	45 mL	10 mL	150 uL	5 mL

Table S2 The control of SiO_2 shell thickness by tuning amount of core (IONPs)

Amounts of IONPs (6.7 mg/mL)	Thickness of SiO_2 shell (nm)
2 mL	19.4 nm
4 mL	5.28 nm
8 mL	3.45 nm