Electronic Supplementary Information (ESI)

$Ru(bpy)_2(phen\text{-}5\text{-}NH_2)^{2+}$ doped Ultrabright and Photostable Fluorescent Silica Nanoparticles

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Characterization of nanoparticles

1. 2.5 mg of dye doped silica nanoparticles dispersed in 10 mL of water to test fluorescence emission, excitation and 3D spectra. The concentration of dye molecules in nanoparticles suspension was analyzed by ICP.
2. The IR spectra of SiO_2 nanoparticles, dye doped SiO_2 nanoparticles and dye molecules show that dye molecules are successfully doped in SiO_2 nanoparticles.

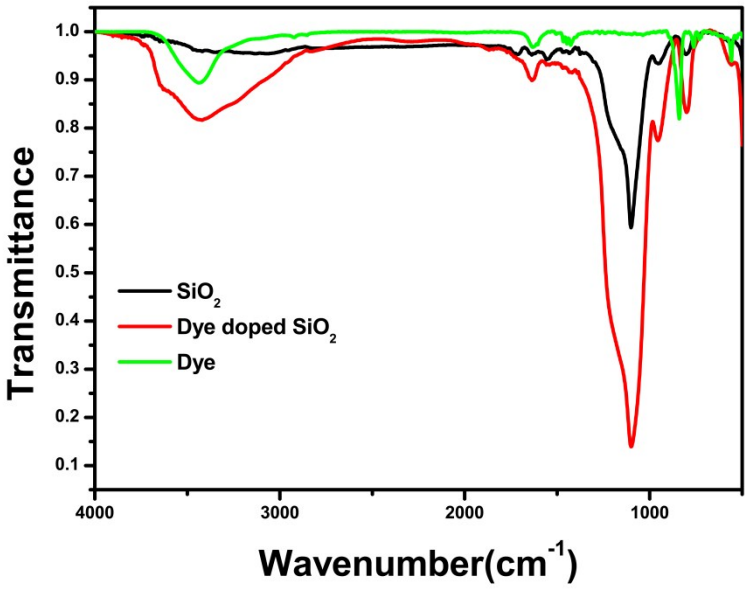

Figure S1. IR spectra of SiO_2 (black), dye doped SiO_2 (red) and dye molecules (green).

3. Figure S2. TEM images and SEM images of nanoparticles. Figure S2a and S2b

showed the uniform dye-doped silica nanoparticles with the diameter around 80 nm. By increasing the addition of ethanol, we could get larger nanoparticles around 120 nm (Figure S2c, S2d). We continuously added more ethanol in the synthesis system, nanoparticles around 180 nm can be obtained (Figure S2e, S2f).

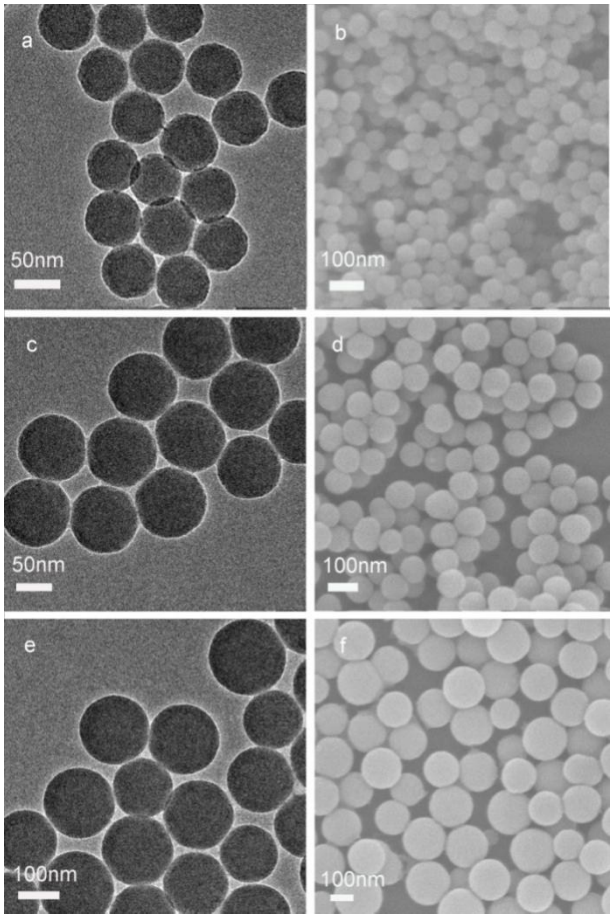

Figure S2. TEM images of synthesized dye doped NPs-2(a), NPs-4(c), NPs-6(e) and SEM images of NPs-2(b), NPs-4(d), NPs-6(f).

4. Table S1 summaries the DLS result of dye doped silica nanoparticles. D_m is the most abundant particles diameter and D_{eff} is the average diameter. The size of nanoparticles becomes larger from NPs-1 to NPs-6. The result is agreed with TEM images.

Table S1. Dynamic light scattering results of nanoparticles

sample	Dm	Deff	PDI
NPs-1	51nm	170nm	0.114
NPs-2	92nm	144nm	0.098
NPs-3	105nm	173nm	0.086
NPs-4	122nm	189nm	0.097
NPs-5	164nm	213nm	0.061
NPs-6	190nm	216nm	0.011

5. The synthesis parameter of NPS- a1 to NPS-a6 are shown in Table S2

Table S2. The synthesis parameter of NPS- a1 to NPS-a6

Sample	Triton X-100	Hexanol	Cyclohexane	TEOS	NH_4OH	H_2O	EtOH	Dye concentration
NPs-a1	1.876 g	1.8 mL	7.5 mL	100 µL	60 µL	280 µL	200 µL	1.81×10^{-4} M
NPs-a2	1.876 g	1.8 mL	7.5 mL	100 µL	60 µL	280 µL	200 µL	1.58×10^{-4} M
NPs-a3	1.876 g	1.8 mL	7.5 mL	100µL	60 µL	280 µL	200 µL	1.35×10^{-4} M
NPs-a4	1.876 g	1.8 mL	7.5 mL	100µL	60 µL	280 µL	200 µL	1.13×10^{-4} M
NPs-a5	1.876 g	1.8 mL	7.5 mL	100 µL	60 µL	280 µL	200 µL	0.90×10^{-4} M
NPs-a6	1.876 g	1.8 mL	7.5 mL	100 µL	60 µL	280 µL	200µL	0.68×10^{-4} M

6. Figure S3 shows SEM images of synthesized dye doped NPs-a1 (a) to NPs-a6 (e), with different dye concentration and identical solvent ratio.

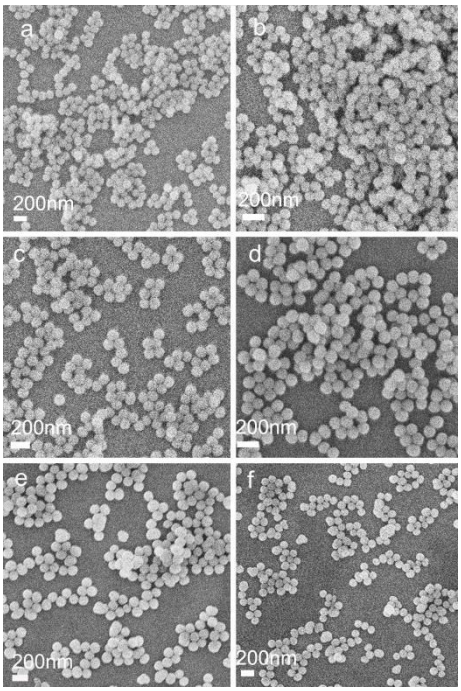

Figure S3. SEM images of synthesized dye doped NPs-a1 (a), NPs-a2 (b), NPs-a3 (c), NPs-a4 (d), NPs-a5 (e) and NPs-a6 (f) with different dye concentration and identical solvent ratio.

7. The emission spectra of as-prepared dye doped silica nanoparticles with different dye concentration and identical solvent ratio are shown in Figure S4.

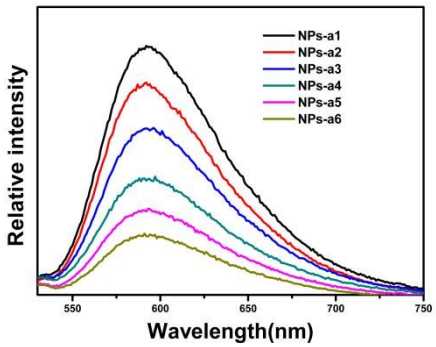

Figure S4. The emission spectra of as-prepared dye doped silica nanoparticles with different dye concentration and identical solvent ratio.

8. The synthesis parameter of NPS- b1 to NPS-b6 are shown in Table S3

Table S3. The synthesis parameter of NPs b1 to b6

Sample	Triton X-100	Hexanol	Cyclohexane	TEOS	NH_4OH	H_2O	EtOH	Dye concentration
NPs-b1	1.876 g	1.8 mL	7.5 mL	100 µL	60 µL	480µL	0 µL	1.35×10^{-4} M
NPs-b2	1.876 g	1.8 mL	7.5 mL	100 µL	60 µL	400 µL	80 µL	1.35×10^{-4} M
NPs-b3	1.876 g	1.8 mL	7.5 mL	100µL	60 µL	320µL	160 µL	1.35×10^{-4} M
NPs-b4	1.876 g	1.8 mL	7.5 mL	100µL	60 µL	280 µL	200 µL	1.35×10^{-4} M
NPs-b5	1.876 g	1.8 mL	7.5 mL	100 µL	60 µL	240 µL	240 µL	1.35×10^{-4} M
NPs-b6	1.876 g	1.8 mL	7.5 mL	100 µL	60 µL	200 µL	280µL	1.35×10^{-4} M

9. Figure S5 are SEM images of NPS-b1 to NPS-b6 with different solvent ratio and identical dye concentration.

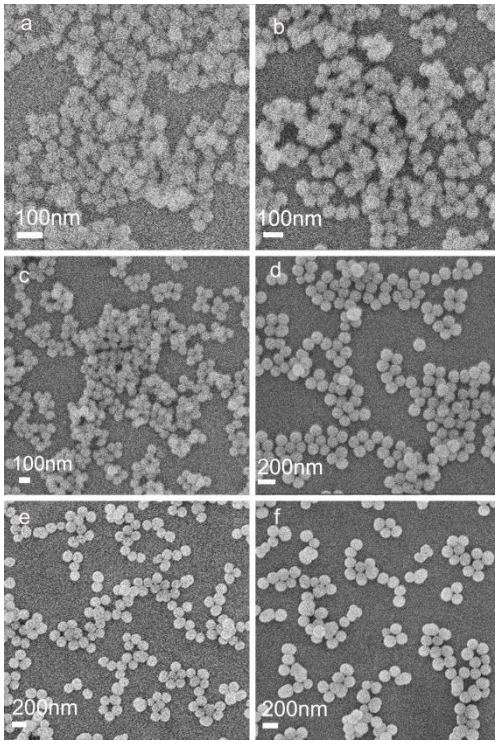

Figure S5. SEM images of nanoparticles NPs-b1(a), NPs-b2(b), NPs-b3(c), NPs-b4(d), NPs-b5(e) and NPs-b6(f) with different solvent ratio and identical dye concentration.

10. Figure S6 shows the emission spectra of dye doped silica nanoparticles with

different solvent ratio and identical dye concentration.

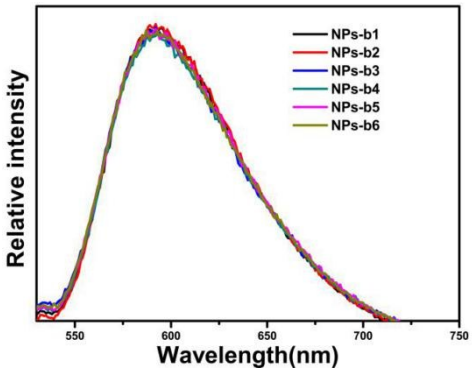

Figure S6. The emission spectra of dye doped silica nanoparticles with different solvent ratio and identical dye concentration.

11. Figure S7 shows the emission spectrum of nanoparticles dispersed in different solvents

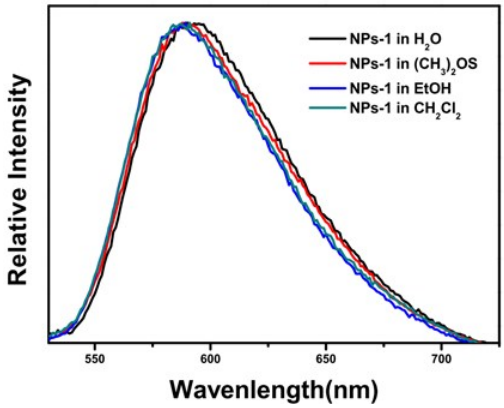

Figure S7. The emission spectrum of nanoparticles dispersed in different solvents.

12. The photobleaching result of NPs-b6 as shown in Figure S8.

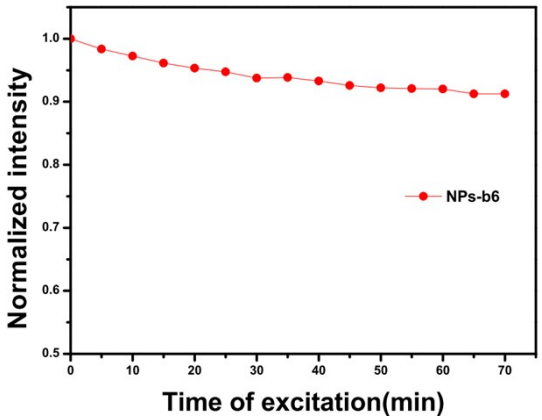

Figure S8. The photobleaching of NPS-b6.