Supplementary Material (ESI) for Journal of Materials Chemistry


# Supplementary Information

## Ratiometric and Reusable Fluorescent Nanoparticles for $Zn^{2+}$ and $H_2PO_4^-$ Detection in Aqueous Solution and Living Cell

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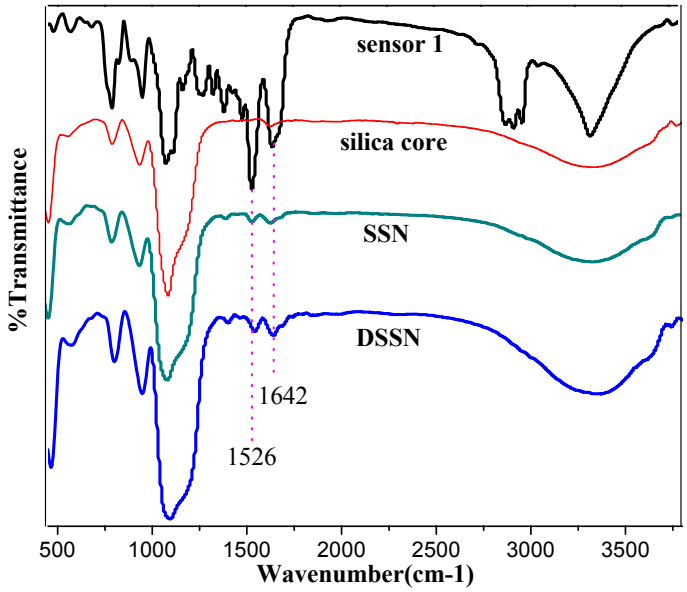


Fig. S1 The FT-IR spectra of sensor 1, silica core, SSN, DSSN.

The bands observed in the wavenumber 1642, 1526 $cm^{-1}$ are attributed to the vibrations of -NH-CO-, quinoline of sensor **1** respectively.

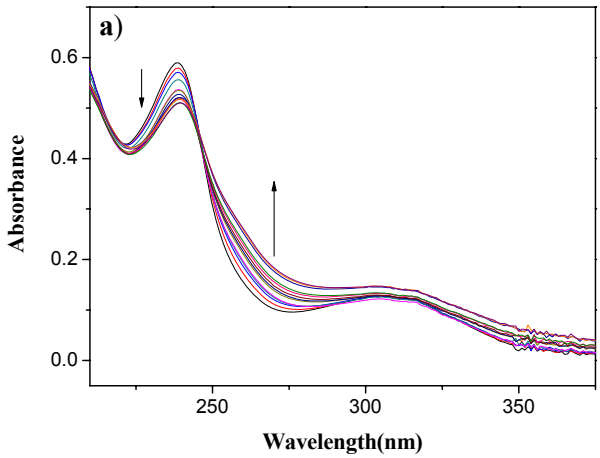


Fig. S2 Absorption spectra of a solution of **SSN** in the presence of increasing $Zn^{2+}$ concentrations (0–1.0 mM) in tris-HCl (0.01 M) solution (water, pH=7.10).Conditions: [sensor-**1**] = $3.1\times10^{-5}$ M, 25 $^{o}$C.

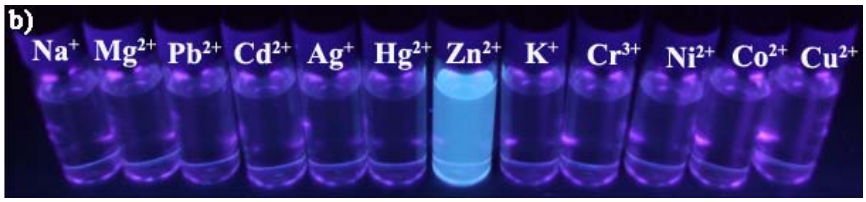


Fig. S3 Fluorescence response of SSN in tris-HCl (0.01 M) solution (water, pH=7.10) with different metal ions. Images were taken under UV irradiation.

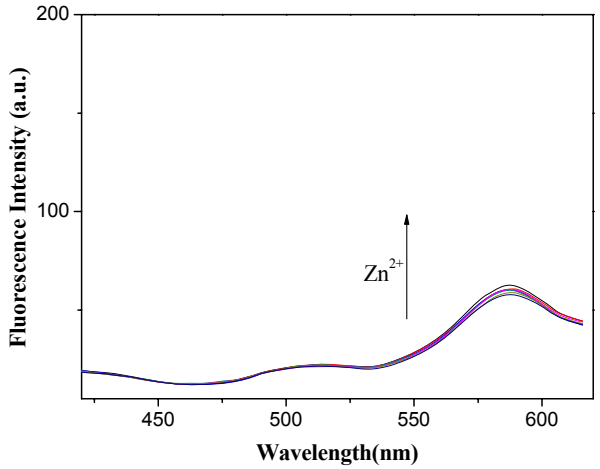


Fig. S4 Emission spectra of a solution of dye-**2**-rich core and pure silica shell fluorescent silica

nanoparticles (**DSN**) in the presence of increasing $Zn^{2+}$ concentrations (0–1.0 mM) in tris-HCl (0.01 M) solution (water, pH=7.10). Conditions: $\lambda_{ex}$=320 nm, $\lambda_{em}$=591 nm, 25 $^{o}$C.

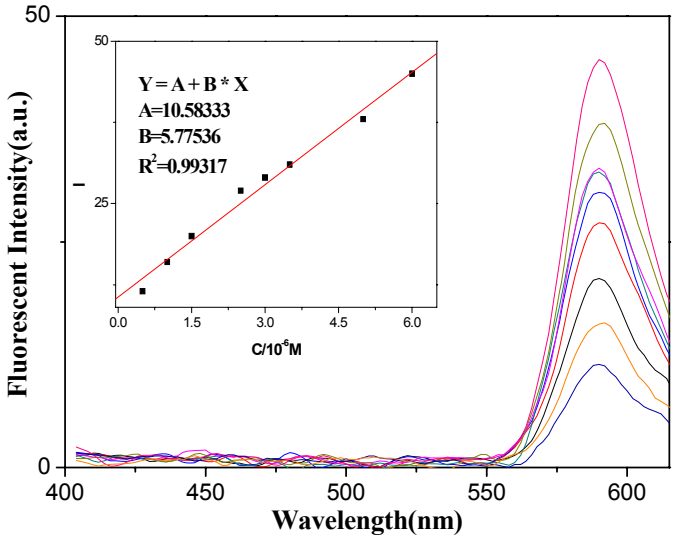


Fig.S5 Emission spectra of different concentration (0~10 μM) of dye-2 in tris-HCl (0.01 M) solution. Inset: Standard curve of different concentration (0~10 μM) of dye-2 in tris-HCl (0.01 M) solution. Conditions: $\lambda_{ex}$=320 nm, $\lambda_{em}$=591 nm, 25 $^{o}$C.

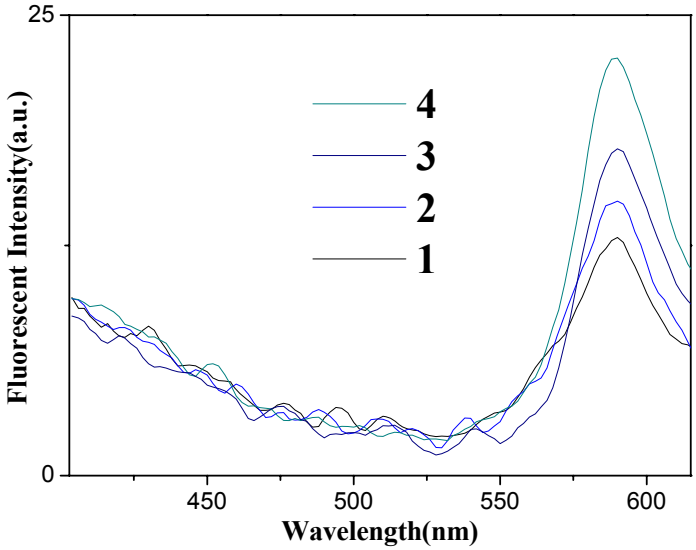


Fig. S6 Emission spectra of a solution of different concentration of **DSSN** in tris-HCl (0.01 M) solution (water, pH=7.10). Conditions: $\lambda_{ex}$=320 nm, $\lambda_{em}$=591 nm, 25 $^{o}$C.

Table S1 The ratio of sensor-1 to Dye-2 combined in the **DSSN** [a]

| | Sensor **1** ($10^{-6}$M) | Dye **2** ($10^{-6}$M) | Ratio of Sensor **1** to Dye **2** |
|---|---|---|---|
| 1 | 25 | 0.397 | 62.9 |
| 2 | 47 | 0.752 | 62.5 |
| 3 | 52 | 0.847 | 61.4 |
| 4 | 130 | 2.09 | 62.2 |

[a] The concentration of sensor-**1** (Fig. S6, Table 1: **1, 2, 3,4**) was evaluated from their absorbance using the ε values of the corresponding compound in aqueous solution (sensor-**1**: λ=243 nm, $\varepsilon=1.73\times10^{4}\ M^{-1}\ cm^{-1}$). The dye-2 was calculated by the standard curve of dye-2 (Fig. S5: Inset, Fig. S6).

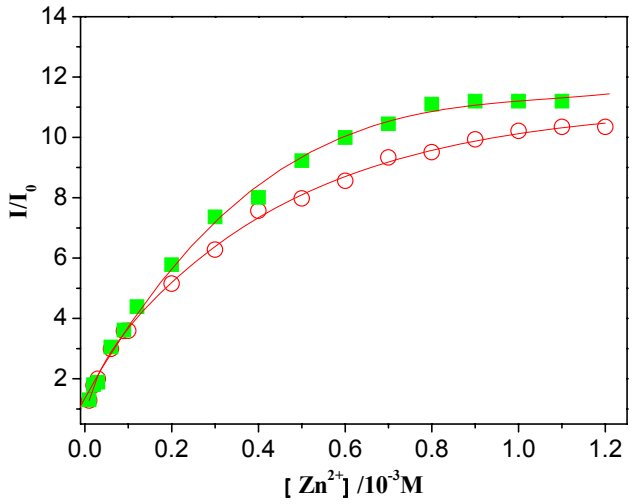


Fig.S7 Fluorescence response of [**SSN:-■-**] and [**DSSN: -○-**] as a function of $Zn^{2+}$ (0~1.0 mM). Conditions: [sensor-**1**] = $3.1\times10^{-5}$ M, $\lambda_{ex}$=320 nm, $\lambda_{em}$=482 nm, 25 $^{o}$C.

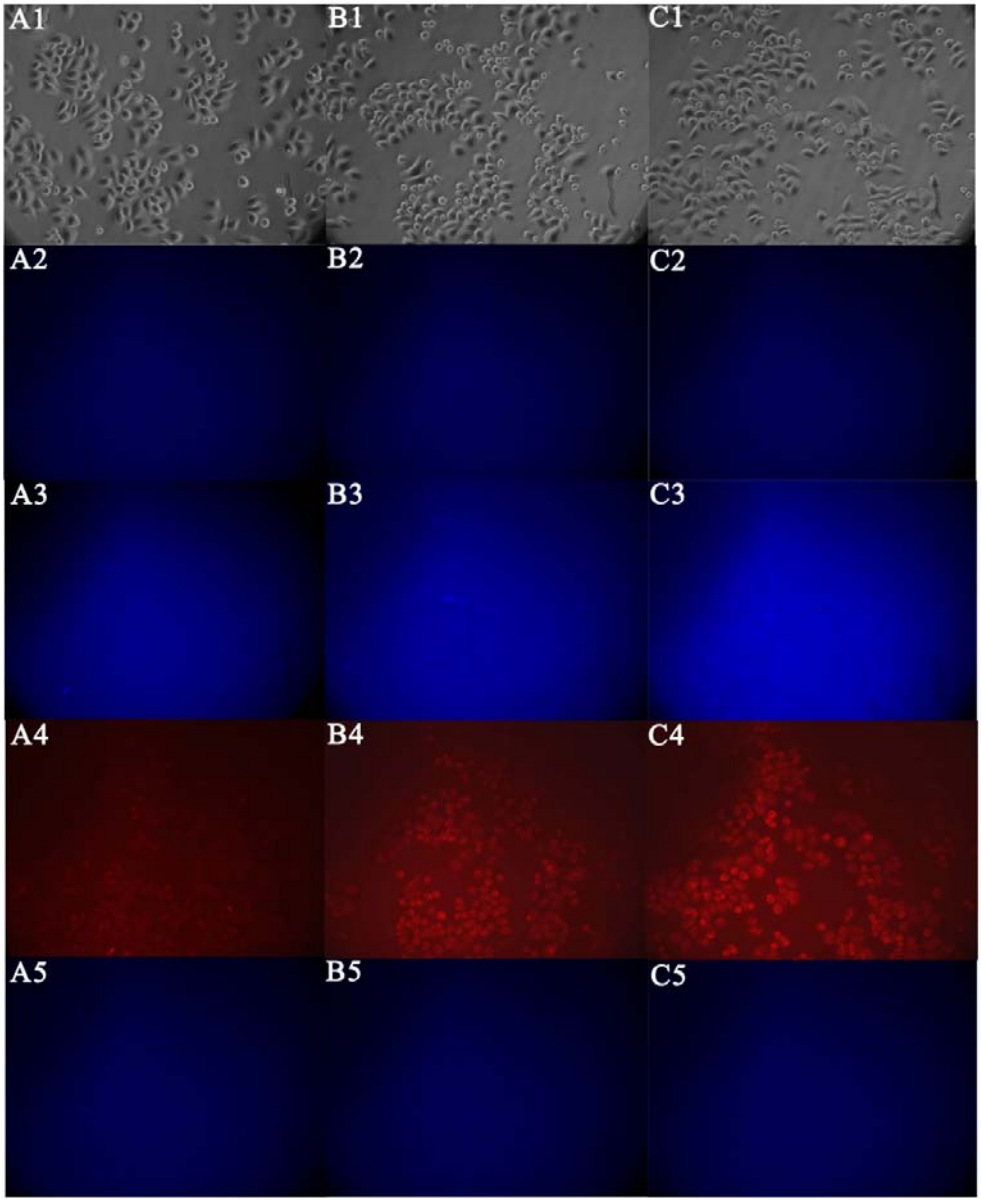


Fig. S8 Fluorescence images of **DSSN** ([sensor-**1**] = $4.0\times10^{-5}$ M) induced by intracellular $Zn^{2+}$ in HeLa cells. (1) Bright-field transmission image of HeLa Cells incubated with **DSSN** and $Zn^{2+}$. (2) Fluorescence image of HeLa cells incubated with **DSSN**. (3) Fluorescence image of HeLa cells and incubated with **DSSN** for 30 min, washed three times, and then further incubated with $Zn^{2+}$ at different concentrations (collected at 430~510 nm (blue)). (4) Fluorescence image of HeLa cells and incubated with **DSSN** for 30 min, washed three times, and then further incubated with $Zn^{2+}$ at different concentrations (collected at 570~650 nm (red)); (5) Fluorescence image of HeLa cells stained with **DSSN** and $Zn^{2+}$ further incubated with EDTA (20 mM) for 25 min. $Zn^{2+}$ concentrations (A: $4\times10^{-5}$ M; B: $4\times10^{-4}$ M; C: $7.5\times10^{-4}$ M )

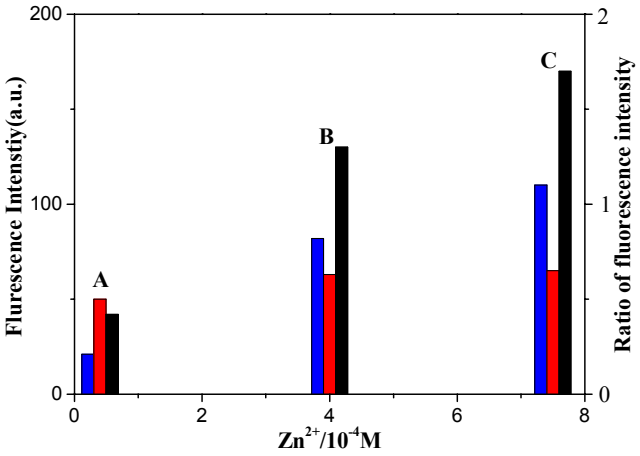


Fig. S9 ImageJ software gave an average emission value of fluorescence images. Bule bar: the mean fluorescent intensity under 430~510 nm (Fig. S8: A3, B3, C3); Red bar: the mean fluorescent intensity under 570~650 nm (Fig. S8: A4, B4, C4). Black bar: the ratio of blue bar to red bar.