

## SUPPORTING INFORMATION

### Energy Transfer Between Amphiphilic Porphyrin Polymer Shells and Upconverting Nanoparticle Cores in Water-Dispersible Nano-assemblies

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#### Estimate of loading of the porphyrin molecules in nano-assemblies TPP-NP and PP1-NP.

The numbers of porphyrin molecules integrated within the nanoparticle systems were estimated using the UV-vis absorption data for each chromophore by comparing the absorptivity of the samples to the free tetra-phenyl porphyrin (**TPP**) and amino porphyrin (**AP**) in solution.<sup>1</sup> The methods are shown in the following tables.

| Calculated mass of single nanoparticle crystal ( <b>NaYF<sub>4</sub>:ErYb</b> )  |   |                          |
|--|---|--------------------------|
| The shape of the particle is approximated to be a sphere and the density of NaYF <sub>4</sub> :ErYb is taken to be the same as for NaYF <sub>4</sub> |   |                          |
| Radius of one particle on average (cm)   | $= 1.175 \times 10^{-6}$                            |                          |
| Volume of particle (cm <sup>3</sup> ) using $v = 4/3\pi r^3$   | $= 4/3 \times 3.14 \times (1.175 \times 10^{-6})^3$ | $= 6.79 \times 10^{-18}$ |
| Density of NaYF <sub>4</sub> (g/cm <sup>3</sup> )  | $= 4.23$  |                          |
| Mass of one single particle (g)  | $= 4.23 \times 6.79 \times 10^{-18}$                | $= 2.87 \times 10^{-17}$ |

<sup>1</sup> All calculations are based on the assumption that the molar absorptivity coefficient ( $\epsilon$ ) of the porphyrins free in solution and incorporated in the nanoparticle systems are the same.

| Calculated loading of porphyrin molecules in <b>TPP-NP</b>              |   |                         |
|---|---|-------------------------|
| For the solution of the free porphyrin <b>TPP</b>                       |   |                         |
| Concentration (M) of <b>TPP</b> in THF                                  | $= 9.8 \times 10^{-6}$                                  |                         |
| A (516 nm)  | $= 0.19298$   |                         |
| Following Beer's law, $\epsilon$ ( $M^{-1}.cm^{-1}$ )                   | $= 19692$   |                         |
| For the solution of the <b>TPP-NP</b> :                                 |   |                         |
| $A_{TPP}$ (516 nm) in <b>TPP-NP</b>                                     | $= 0.20882$   |                         |
| Concentration (M) of porphyrin <b>TPP</b> in <b>TPP-NP</b> <sup>2</sup> |   | $= 1.06 \times 10^{-5}$ |
| V (L) of sample   | $= 9.00 \times 10^{-4}$                                 |                         |
| Moles of porphyrin <b>TPP</b>   | $= (1.06 \times 10^{-5}) \times (9.00 \times 10^{-4})$  | $= 9.54 \times 10^{-9}$ |
| Molecular equivalents of <b>TPP</b>                                     | $= (9.54 \times 10^{-9}) \times (6.023 \times 10^{23})$ | $= 5.75 \times 10^{15}$ |
| Mass (g) of particles in sample <sup>3</sup>                            |   | $= 3.23 \times 10^{-3}$ |
| Mass (g) of one particle  | $= 2.87 \times 10^{-17}$                                |                         |
| Number of particles   | $= 3.23 \times 10^{-3} / (2.87 \times 10^{-17})$        | $= 1.13 \times 10^{14}$ |
| Loading of porphyrin <b>TPP</b> per particle                            | $= (5.75 \times 10^{15}) / (1.13 \times 10^{14})$       | $= 51$                  |

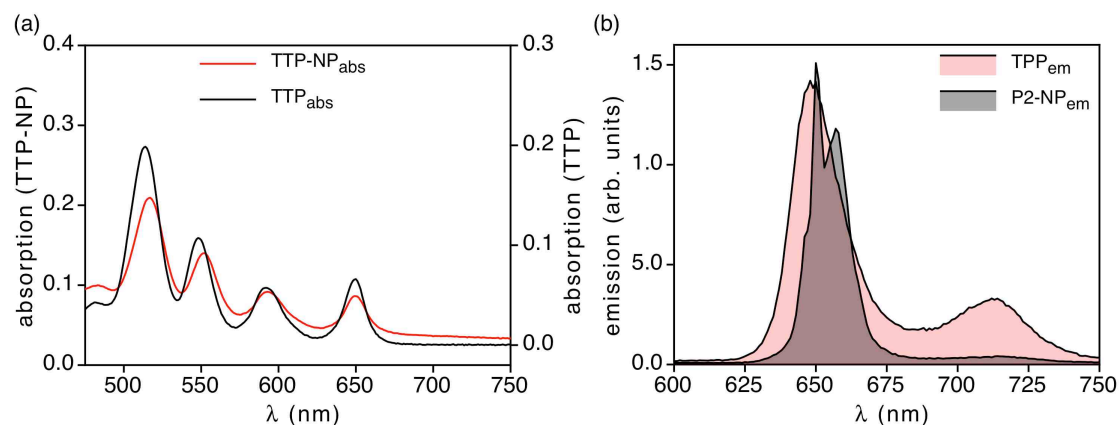
| Calculated loading of porphyrin molecules in <b>PP1-NP</b>                         |   |                         |
|--|---|-------------------------|
| For the solution of the free porphyrin <b>AP</b>                                   |   |                         |
| Concentration (M) of <b>AP</b> in THF  | $= 1 \times 10^{-5}$                                    |                         |
| A (516 nm)   | $= 0.08682$   |                         |
| Following Beer's law, $\epsilon$ ( $M^{-1}.cm^{-1}$ )                              | $= 21705$   |                         |
| For the solution of the <b>PP1-NP</b> :  |   |                         |
| $A_{PP1}$ (516 nm) in <b>PP1-NP</b>  | $= 0.6293$  |                         |
| Concentration (M) of porphyrinic compound <b>PP1</b> in <b>PP1-NP</b> <sup>4</sup> |   | $= 7.24 \times 10^{-5}$ |
| V (L) of sample  | $= 9.00 \times 10^{-4}$                                 |                         |
| Moles of porphyrinic compound <b>PP1</b>   | $= (7.23 \times 10^{-5}) \times (9.00 \times 10^{-4})$  | $= 6.51 \times 10^{-8}$ |
| Molecular equivalents of compound <b>PP1</b>                                       | $= (6.51 \times 10^{-8}) \times (6.023 \times 10^{23})$ | $= 3.92 \times 10^{16}$ |
| Mass (g) of particles in sample <sup>5</sup>                                       | $= 3.4 \times 10^{-3} \times 76.2\%$                    | $= 2.59 \times 10^{-3}$ |
| Mass (g) of one particle   | $= 2.87 \times 10^{-17}$                                |                         |
| Number of particles  | $= 2.59 \times 10^{-3} / (2.87 \times 10^{-17})$        | $= 9.02 \times 10^{13}$ |
| Loading of porphyrin molecules per particle  | $= (3.92 \times 10^{16}) / (9.02 \times 10^{13})$       | $= 435$                 |

<sup>2</sup> Following Beer's law.

<sup>3</sup> Assuming 100% of the particles was transferred from the organic solution to water.

<sup>4</sup> Following Beer's law.

<sup>5</sup> The wt-% of the nanoparticle was determined by TGA.



**Figure S1.** (a) Selective UV-vis absorption spectra of an aqueous solution ( $1.1 \times 10^{-5}$  M)<sup>6</sup> of the nano-assemblies (**TTP-NP**) containing the UCNPs and tetra-phenyl porphyrin wrapped with the amphiphilic polymer (red line), and a THF solution ( $9.8 \times 10^{-6}$  M) of the free tetra-phenyl porphyrin **TPP** (black line). (b) Comparison of the red emissions for the aqueous solution of **TTP-NP** (grey shaded area) when excited with 980 nm light) and the THF solution of tetra-phenyl porphyrin **TPP** (red shaded area) when excited with 550 nm light).

<sup>6</sup> This concentration is determined from the UV-vis spectrum of **TTP-NP** based on the assumption that the molar absorption coefficient of the tetra-phenyl porphyrin (**TPP**) is the same as that for the porphyrins in the **TTP-NP nano-assembly**.