Supplementary Information for

Cysteine-induced one-pot synthesis of Au nanoparticle chains with tuneable NIR absorption and application in photothermal-chemo cancer therapy

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Materials

Chloroauric acid (HAuCl₄·4H₂O), silver nitrate and L-cysteine (L-cys) were purchased from Aldrich. Sodium hydroxide (NaOH), TEOS, pyrogallol and sodium borohydride (NaBH₄) were purchased from Shanghai Chemical Reagent Corp. Doxorubicin hydrochloride (DOX) was purchased from Beyotime Biotechnology Co., Ltd. NH₂-PEG-SH (Mw=500) was purchased from Yarebio (Shanghai, China). Phosphate buffer (PBS), Parenzyme and all the other biological reagents, including 1640 culture medium, fetal bovine serum (FBS) were purchased from Sangon Biotech.
MCF-7 cells were obtained from the Chinese Academy of Sciences Cells Bank. Water used in this experiment was purified by distillation of deionized water.

The calculation of photothermal conversion efficiency

According to previous literatures, the photothermal conversion efficiencies of AuNCs@mSiO$_2$ was calculated according to following equation

$$\eta = \frac{hs(T_{\text{max}} - T_{\text{surr}}) - Q_{\text{dis}}}{I(1 - 10^{-A_{808}})} \times 100\%$$

Where h is heat transfer coefficient, S is the surface area of the container. $T_{\text{max}}$ is the equilibrium temperature, $T_{\text{surr}}$ represent ambient temperature. These parameters can be calculated according to Fig. S5. The $Q_{\text{dis}}$ means the dissipated heat absorbed by the quartz cell under laser irradiation and it was measured independently to be 0.086 W/°C using a quartz cuvette cell containing pure water. I is incident laser power (2 W cm$^{-2}$), $A_{808}$ is the absorbance of particles at 808 nm. The photothermal conversion efficiencies of AuNCs@mSiO$_2$ is 31.9%.
Table. S1. Details of Sample d-i including diameter, length, assembly number and wavenumber of LSPR.

<table>
<thead>
<tr>
<th>L-cys (μL)</th>
<th>Diameter (nm)</th>
<th>Length (nm)</th>
<th>Assembly Number</th>
<th>LSPR (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>14.2 ± 0.8</td>
<td>50.8 ± 5</td>
<td>1</td>
<td>808</td>
</tr>
<tr>
<td>10</td>
<td>12.1 ± 1.7</td>
<td>31.7 ± 5.5</td>
<td>1</td>
<td>672</td>
</tr>
<tr>
<td>40</td>
<td>11.6 ± 1.9</td>
<td>20.4 ± 4.3</td>
<td>3 ± 2</td>
<td>642</td>
</tr>
<tr>
<td>80</td>
<td>11.9 ± 1.9</td>
<td>16.3 ± 5.6</td>
<td>11 ± 3</td>
<td>808</td>
</tr>
<tr>
<td>140</td>
<td>11.1 ± 2.2</td>
<td>12.6 ± 3.7</td>
<td>19 ± 5</td>
<td>755</td>
</tr>
<tr>
<td>200</td>
<td>11.1 ± 2.1</td>
<td>11.5 ± 2.9</td>
<td>—</td>
<td>718</td>
</tr>
</tbody>
</table>
Fig. S1. UV spectrum of Fig. 1c with wavelength ranging from 400 to 600 nm.
Fig. S2. TEM image of AuNPs with the addition Lysine (40 μL, 0.5 mM)
Fig. S3. The plot of temperature change ($\Delta T$) of a fixed concentration of AuNCs changed with the volume of L-cys.
Fig. S4. TEM image of AuNCs after photothermal conversion experiment.
Fig. S5. Enlarged TEM image of a single AuNCs coated with Mesoporous SiO$_2$. 
Fig. S6. UV-Vis spectra of AuNCs and AuNCs@mSiO2.
Fig. S7. The plot of temperature change (ΔT) of different concentration of AuNCs@mSiO$_2$. 
Fig. S8. (a) Photothermal curves of AuNCs@mSiO$_2$ aqueous solution (100 μg mL$^{-1}$, Au) under 808 nm laser irradiation (2 W cm$^{-2}$, 6 min) and a subsequent cooling process. (b) Time constant for heat transfer from the system is determined to be $\tau_s = 175.15$ by applying the linear time data from the cooling period versus negative natural logarithm of driving force temperature. (c) Absorption spectrum of AuNCs@mSiO$_2$ aqueous solution (100 μg mL$^{-1}$).
Fig. S9. TEM image of AuNCs@mSiO$_2$ after 5 heating-cooling cycles.
Fig. S10. UV-Vis spectra of DOX before and after interaction with the AuNCs@mSiO$_2$.
Fig. S11. Cell viability of MCF-7 and HEPD6-C7 after incubation with different AuNCs@mSiO$_2$ concentration.
Fig. S12. Mean tumor weights of each group at the last day of experiment. Data are presented as means ± SD (n = 3).
**Fig. S13.** Tumor inhibition rate of each group at the last day of experiment.
Fig. S14. H&E staining images of major organs with different treatment. Scale bars is 100 μm.