Supporting Information

Precise Control Over the Silica Shell Thickness and Finding the Optimal Thickness for the Peak Heat Diffusion Property of AuNR@SiO₂

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Materials

HAuCl₄ (99.99%), NaBH₄ (99.9%), cetyltrimethyl ammonium bromide (CTAB; ≥ 99.0%), L-ascorbic acid (≥99.0%), AgNO₃ (≥99.0%), and tetraethyl orthosilicate (TEOS; 99.9%) were purchased from Sigma-Aldrich (St. Louis, MO, USA). NaOH (≥97.0%) and isopropyl alcohol (IPA; 99.5%) were purchased from Daejung Chemical & Metal Co., Ltd. (Shiheung, South Korea). The human tongue squamous carcinoma (HSC-3) cell line was purchased from Sigma-Aldrich (St. Louis, MO, USA). Dulbecco’s modified Eagle’s medium (DMEM) was obtained from HyClone (Waltham, MA, USA). CellTiter 96® AQueous One Solution was purchased from Promega (Madison, WI, USA).

Instruments

Transmission electron microscopy (TEM, H-7100, Hitachi, Tokyo, Japan) was used for TEM analysis. The extinction spectra were obtained using a UV-visible spectrometer (SCINCO, South Korea). Bright-field and dark-field images were obtained using a microscope (Olympus IX73, Tokyo, Japan) equipped with a dark-field condenser (NA 0.8–0.92; Tokyo, Japan). The photothermal effects were studied using a continuous-wave (CW) diode 808 nm NIR laser with an output power of 4.8 W (Chang-chun New Industries Optoelectronics, China). A thermometer (YF-160A K type, Tenmars Electronics Co., Ltd., Taiwan) and an infrared thermal imaging camera (FLIR C2, FLIR Systems Inc., USA) were used to measure the temperature and obtain thermal imaging, respectively. X-ray diffraction (XRD) measurements were performed using a X-ray diffractometer (SmartLab, Rigaku, Japan) with a Cu Kα radiation source (45 kV, 200 mA, wavelength : 1.5412 Å). X-ray photoelectron spectroscopy (XPS) measurements were performed using a X-ray photoelectron spectroscope (X-TOOL, ULVAC-PHI, Japan) with a Ar sputter gun (> 5.0 µA, 5 kV). Raman spectra were acquired using an inverted Raman microscope (NOST, South
Korea). An Epoch™ Microplate Spectrophotometer (BioTek Inc., Winooski, USA) was used to assess the cell viability.
Figure S1. TEM images of CTAB-AuNRs@SiO$_2$ prepared with (a) 0.01 M, (b) 0.05 M, and (c) 0.1 M NaOH, and (d) UV-Visible spectra. TEM images of CTAB-AuNRs@SiO$_2$ prepared with (e) 90 μL, (f) 180 μL, and (g) 270 μL of NH$_4$OH, and (i) UV-Visible spectra. TEM images of the surface of CTAB-AuNRs@SiO$_2$ prepared using (i) MeOH, (j) EtOH, and (k) IPA, and (l) UV-Visible spectra.
Figure S2. (a) UV spectra of CTAB-AuNRs and AuNR@SiO$_2$ with 5, 10, 15, 20, 25, 30, 35, and 40 nm SiO$_2$ shells, (b) changes of $\lambda_{\text{max}}$ of the CTAB-AuNRs and AuNR@SiO$_2$ with 5, 10, 15, 20, 25, 30, 35, and 40 nm SiO$_2$ shells.
Figure S3. Experimental setup of the 808 nm CW laser at a power density of 1.25 W/cm².
Figure S4. (a) Cooling curves of DW, CTAB-AuNRs, and AuNR@SiO$_2$. Time constants ($\tau_a$) and photothermal conversion efficiencies ($\eta$) of (b) CTAB-AuNRs and AuNR@SiO$_2$ ((c) 5, (d) 10, (e) 15, (f) 20, (g) 25, (h) 30, (i) 35, and (j) 40 nm) for heat transfer from the system.
Figure S5. (a) Raman spectrum, (b) chemical structure, and (c) vibration modes of CTAB.¹
Figure S6. TEM images of the as-prepared (a) AuNR@SiO₂ and (b) AuNR@LD-SiO₂; (c) X-ray diffraction patterns and (d) X-ray photoelectron spectroscopy spectra of the CTAB-AuNRs (black line), AuNR@LD-SiO₂ (red line), and AuNR@SiO₂ (green line).
Figure S7. (a) Content of the AuNRs (OD = 1.5) in the cells measured at 780 nm and (b) bright-field and dark-field images of cells incubated with CTAB-AuNRs and AuNR@SiO$_2$ with defined silica shell thicknesses (5, 10, 15, 20, 25, 30, 35, and 40 nm).
REFERENCES