X-ray-triggered NO-released Bi–SNO nanoparticles: all-in-one nano-radiosensitizer with photothermal/gas therapy for enhanced radiotherapy

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Calculation of the Photothermal Conversion Efficiency

The photothermal conversion efficiency ($\eta$) is calculated as follows:

$$\eta = \frac{hS(T_{\text{max}} - T_{\text{surr}}) - Q_{\text{dis}}}{I(1 - 10^{\lambda/A})}$$

When $\eta$ is the thermal conversion efficiency of the nanomaterial, $S$ is the area of the sample, $T_{\text{max}}$ represents the highest temperature (51.5°C) of the sample after irradiation. $T_{\text{surr}}$ stands for the ambient temperature (25.6°C). $Q_{\text{dis}}$ is the heat of the blank solvent, which is measured be 20.0 mW. $A_\lambda$ is the absorbance value of the sample at the excitation wavelength $\lambda$ ($\lambda = 808$ nm) and $A$ means the absorption intensity of Bi-SNO NPs solution (300 µg mL$^{-1}$), and $I$ is the laser power based on the equation (0.8 W/cm$^2$). $hs$ can be applied the linear time date from the cooling period vs -In $\theta$ (Fig. 2e).

$$hs = \frac{mc}{k}$$

Figures

![Fig. S1 The size distribution histograms of Bi-SH, Bi-TEOS, Bi-MPTES, and Bi-SNO NPs, respectively.](image-url)
Fig. S2 (a): UV-vis absorbance spectra of Bi-SNO with different concentrations at room temperature. (b): A linear relationship for the optical absorbance at 808 nm as a function of Bi-SNO concentration (50, 100, 150, 200, 250, 300, and 400 µg mL⁻¹).

Fig. S3 (a) The particle size distributions of Bi-SNO NPs in different solvents (including phosphate buffered solution (PBS), saline, and serum) measured by dynamic light scattering (DLS). (b) The long-term stability of Bi-SNO NPs in various solvents throughout 14-day (336 h).
Fig. S4 X-ray triggered NO release from Bi-SNO in zebrafish larvae. (a) CLMS images of zebrafish incubated with DAF-FM-DA under 5 Gy radiation. (b) CLMS images of zebrafish incubated with Bi-SNO and DAF-FM-DA upon exposure to 5 Gy radiation.

Fig. S5 (a) Calibration curve of absorbance at 540 nm versus the concentration of nitrite (NaNO₂). (b) Quantitative evaluation of NO release from various concentration of Bi-SNO in saline (b), HeLa cells (c), and zebrafish (d).
zebrafish (d) after exposure to X-ray radiation (5 Gy). All experiments were performed according to the Griess kit protocols.

Fig. S6 Immunofluorescent staining of HIF-1α (hypoxia probe, green) and nuclei (DAPI, blue) of tumor slices after various treatment.

Fig. S7 Temperature change curves of tumor-bearing mice intratumorally injected with saline and Bi-SNO.