Supporting Information of

A Hybrid Nanozymes in situ Oxygen Supply Synergistic Photothermal-/Chemotherapy of Cancer Management

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Figure S1. XRD results of Ru NPs.

Figure S2. TEM micrograph of erythrocyte membrane vesicles. RBCm has a particle size of approximately 200 nm.
Magnified image shows that RBCm has a good saclike appearance [1, 2].

Figure S3. SEM micrograph of RBCm@Ru@MnO₂, it has good spherical morphology and dispersion.

Figure S4. BCA kit test protein of RBCm@Ru@MnO₂, the surface protein loading rate of RBCm@Ru@MnO₂ was determined by the BCA kit to be about 53.28% [3].
**Figure S5.** The particle size changes of Ru@MnO₂ and RBCm@Ru@MnO₂ after being placed in cell culture medium (pH 7.4) for 7 days. Compared with Ru@MnO₂, RBCm@Ru@MnO₂ still has good dispersion, it is indicated that the coating of the erythrocyte membrane can give Ru@MnO₂ a good physiological activity.

**Figure S6.** Pictures of RBCm@Ru-MnO₂@DOX dispersed in dispersed in pH 5.5 solutions with or without H₂O₂. Produces a large amount of O₂ to alleviate the hypoxia of solid tumors and indirectly prevent tumor cell regeneration.
Figure S7. Infrared thermal images of Water, Ru@MnO₂ and RBCm@Ru@MnO₂.

Figure S8. Linear time data versus lnθ obtained from the cooling period. RBCm@Ru-MnO₂ exhibited high photothermal conversion efficiency (36.99%).

The photothermal conversion efficiency (η) of RBCm@Ru-MnO₂ can be calculated as following equations:

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

Where η is the photothermal conversion efficiency (×100%), T_{max} is the highest temperature of the sample, T_{surr} is the
ambient temperature (unit: °C), I is the laser power used, A808 is the absorbance value (dimensionless) of the sample at the excitation wavelength, Qdis is the change in heat when the reagent is blank, h is the thermal conversion efficiency of the system and S is the surface area of the vessel. The value of Qdis can be determined separately from the reagent blank.

\[ h_s = \frac{(m \times C_{H2O})}{T_s} \]

Where m is the mass of the solution (unit: g), C_{H2O} is the specific heat capacity of water (4.2 J × g\(^{-1}\) × °C\(^{-1}\)), T is the time constant of the system (dimensionless). The value of T can be calculated by equation (3):

\[ t = -T_s \ln(\Theta) = -T_s \ln(T-T_{surr})/(T_{max}-T_{surr}) \]

Where t is the time during cooling (unit: s), \( \Theta \) is the thermal drive constant, T is the instantaneous temperature at t time, Tmax is the highest temperature of the sample. Tsurr is the ambient temperature, thus the T value can be obtained by linearly fitting the negative value of the cooling time to the natural logarithm of the thermal drive constant [4].

![Figure S9. MTT of RBCm@Ru@MnO2@DOX with or without Laser. Chemotherapy/photothermal therapy significantly inhibits the activity of tumor cells.](image)

![Figure S10. Degree of fluorescence on RBCm@Ru@MnO2@DOX, the fluorescence density of RBCm@Ru@MnO2@DOX appears to be positively correlated with the concentration of RBCm@Ru@MnO2@DOX.](image)
Indicates the possibility that it can be used for in vivo tracking.

**Figure S11.** Histological analyses of the major tissues after therapy with Ru@MnO$_2$@DOX, RBCm@Ru@MnO$_2$@DOX with Laser (1W/cm$^2$) or without Laser. The results indicate good safety for normal tissues at given drug concentration. Scale bar: 100 m.

**References**


