Supporting Information

CO_2 Delivery to Accelerate Incisional Wound Healing Following Single Irradiation of Near-Infrared Lamp on the Coordinated Colloids

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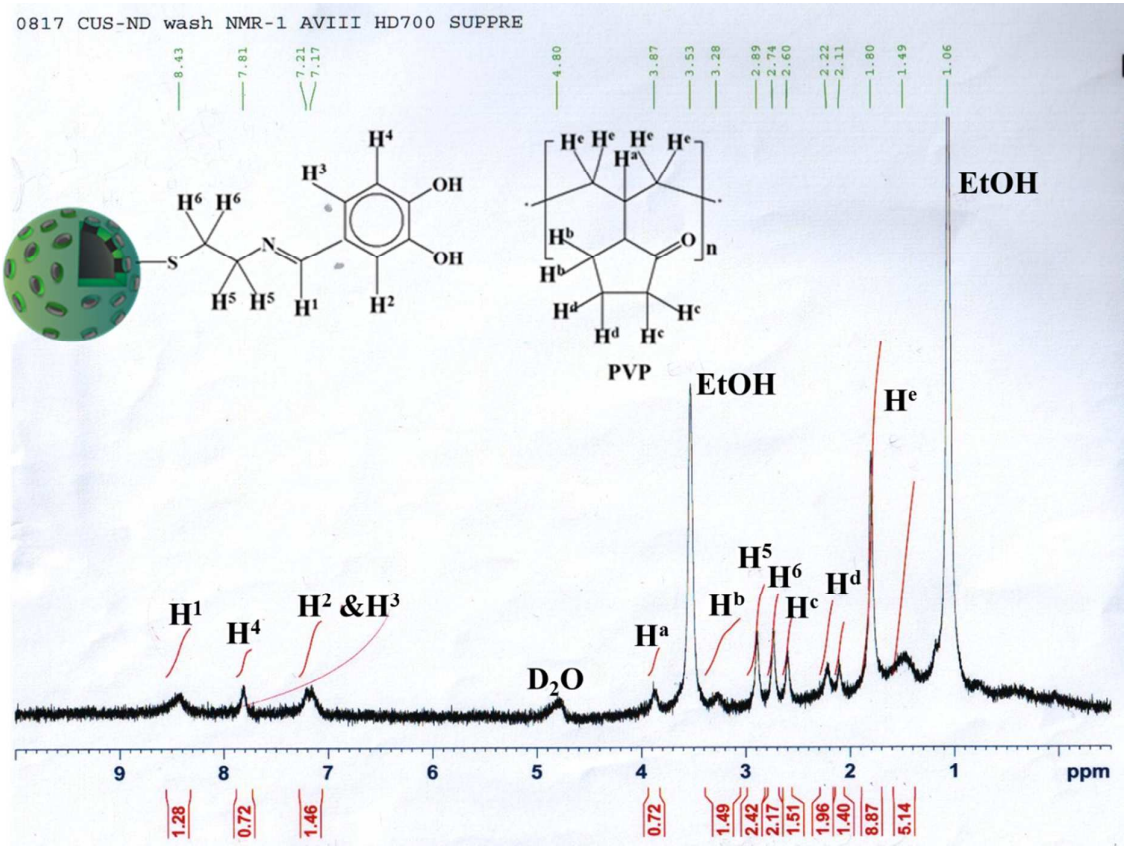

Figure S1. The ^{1}H NMR spectrum showed the proton chemical shifts correlation with the different types of H atoms for cysteamine and dopamine. All H atoms were classified as marks (H^1, H^2, H^3, H^4, H^5 and H^6) in the chemical structured view that correlated to specific shift positions. Some hydrogen signals (H^a, H^b, H^c, H^d and H^e) can be observed in the spectrum contributing from the PVP on the *h*-CuS NPs. The ^{1}H NMR spectrum was obtained by the superconducting FT NMR spectrometer (Bruker, AVANCE III HD 700 MHz).

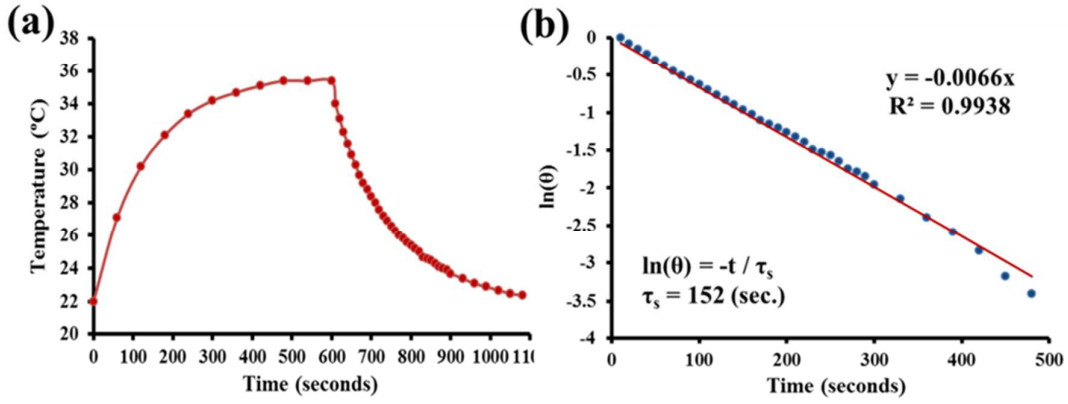

Figure S2. The photothermal conversion studies for *h*-CuS NPs. (a)The heating/ cooling curves of 50 ppm *h*-CuS solution was obtained with/without the 808 nm laser exposure. (b) The time constant (τ_s) can be calculated from a linear relationship of cooling period vs. ln(θ).

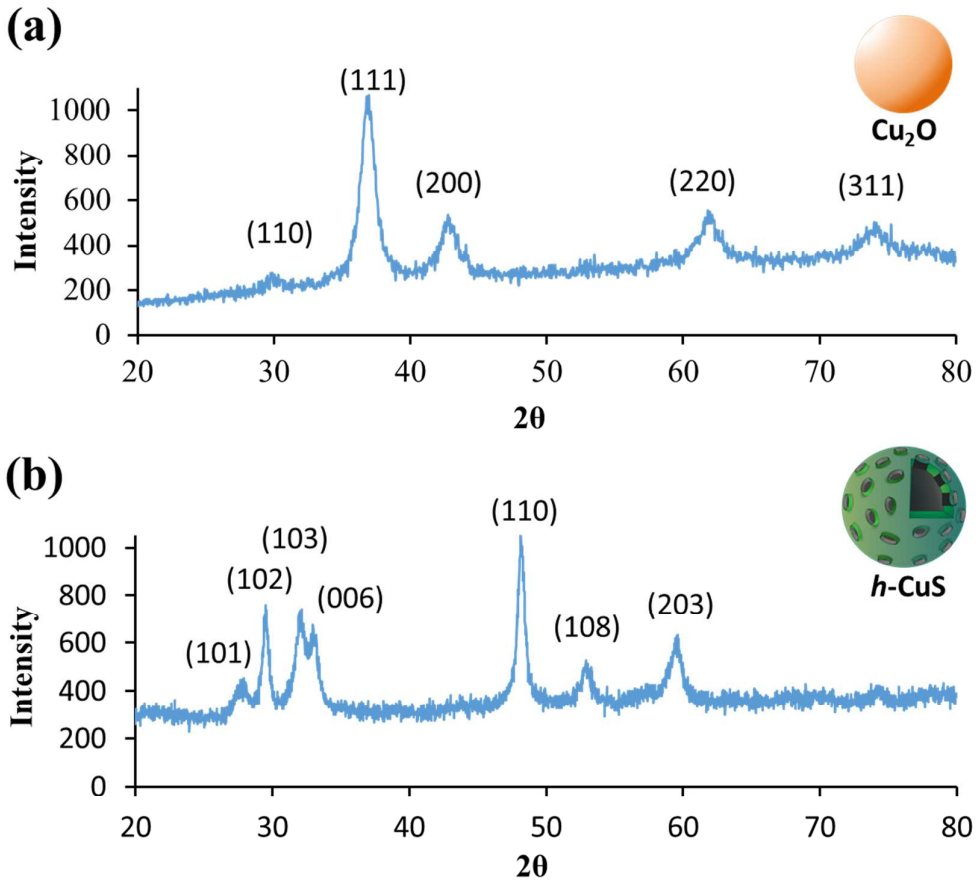

Figure S3. XRD measurements of copper oxide and copper sulfide NPs. XRD patterns of (a) Cu_2O NPs and (b) *h*-CuS NPs. The synthesized templates were Cu_2O (JCPDS Card No. 5-0667), and that the templates were then converted to *h*-CuS (JCPDS Card No. 6-0464).

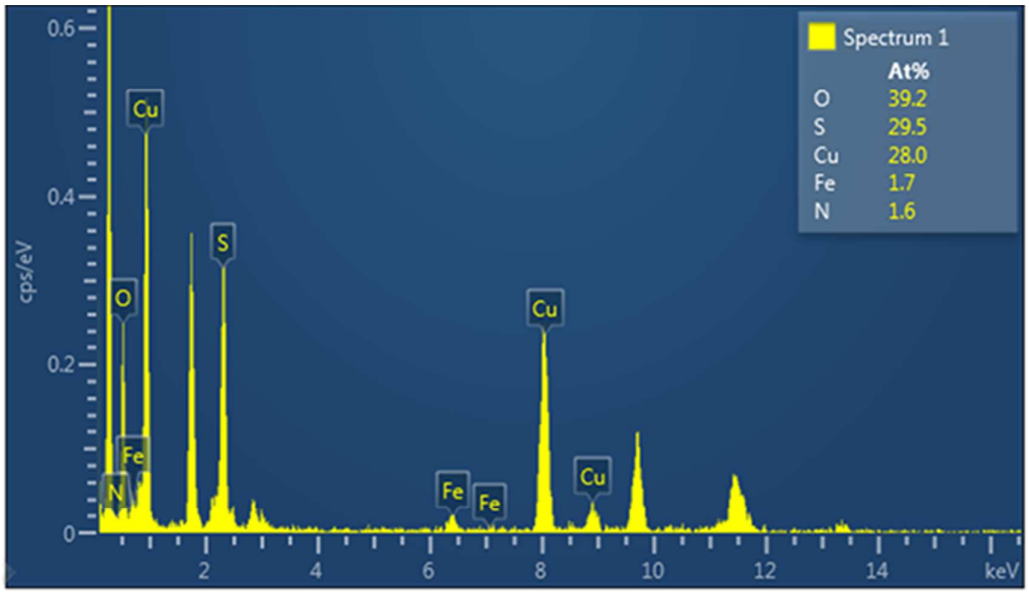

Figure S4. EDS elemental analysis on the *h*-CuS/BC NPs. The element ratios were obtained to be 39.2, 29.5, 28, 1.7, and 1.6 % corresponding to O, S, Cu, Fe and N, respectively. It should be mentioned that the oxide layer exists on the Au gird as well as the contribution of dopamine and BC giving the excessive O signal.

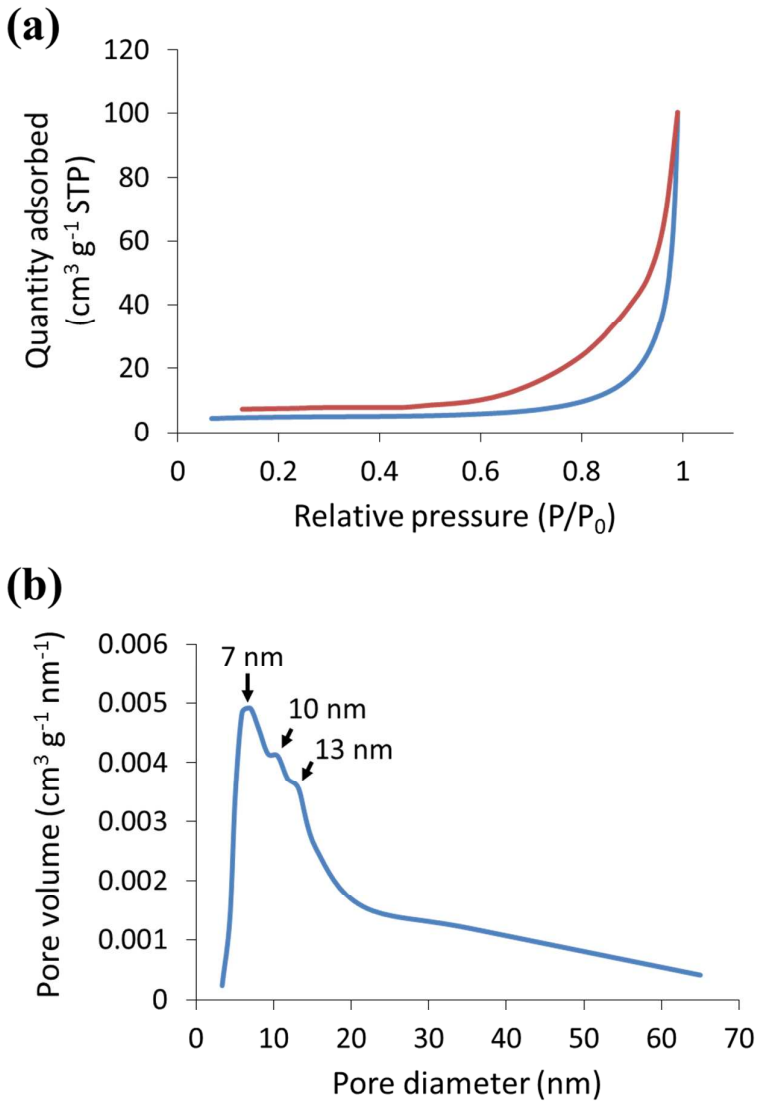

Figure S5. Measurements of surface area and pore size distribution. (a) N_2 adsorption-desorption isotherm of *h*-CuS NPs. (b) The Barrett–Joyner–Halenda (BJH) pore size distribution plot of *h*-CuS NPs.

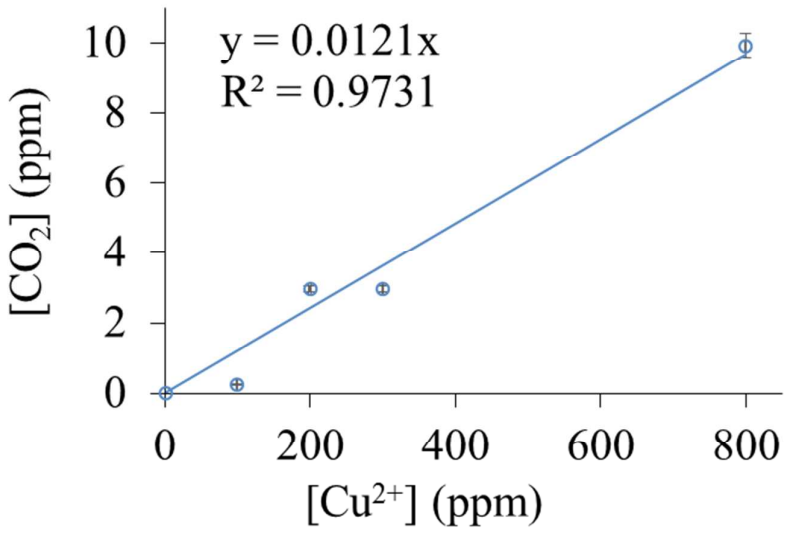

Figure S6. A linear relation of CO_2 amount vs. *h*-CuS/BC dosage at 50 °C. 50 °C can ensure all BC carried by *h*-CuS NPs to decompose for CO_2 generation. The different copper ion concentrations of the *h*-CuS/BC colloidal solutions containing 1 mM $Ca(OH)_2$ were heated for 30 min at 50 °C to yield CO_2 for the formation of $CaCO_3$. After centrifugation (14000 rpm, 30 min), the precipitates were collected to determine the concentration of the calcium by ICP-AES measurements for quantitation of $CaCO_3$. Following $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$, the amount of CO_2 can be derived once the quantity of $CaCO_3$ was obtained. All of the results were obtained triplicate.

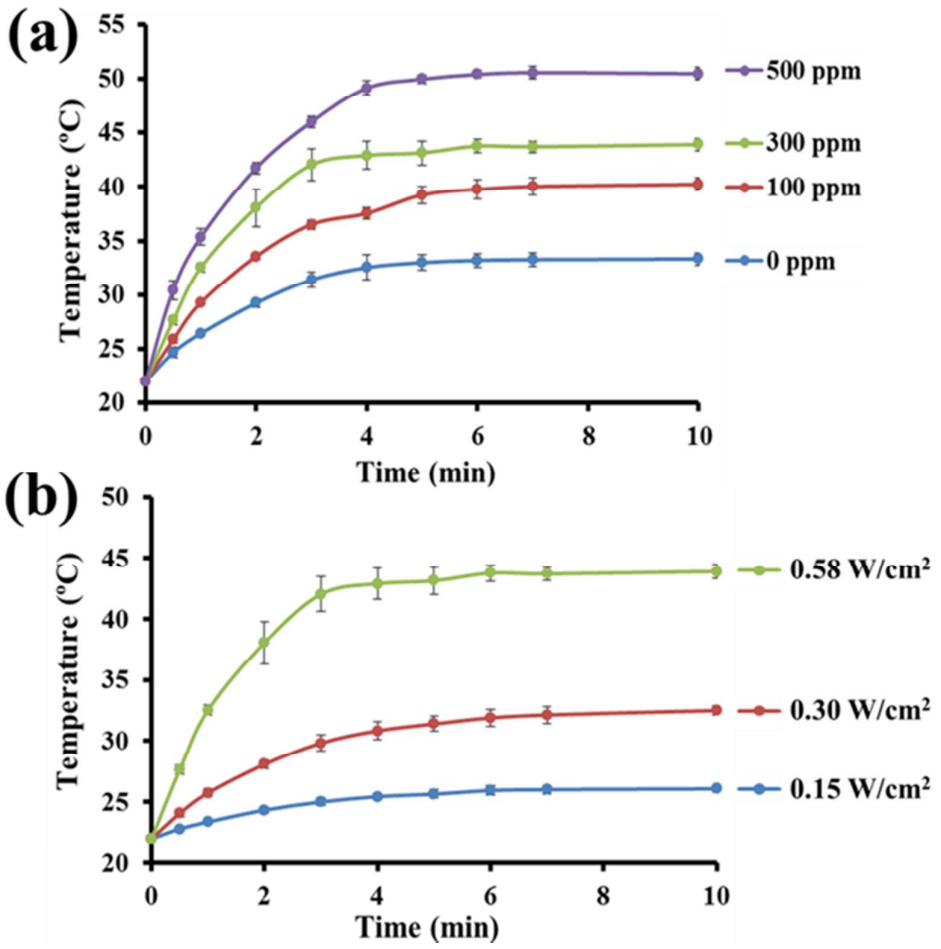

Figure S7. Photothermal heating curves of the *h*-CuS colloidal solutions upon NIR lamp exposure. (a) Different Cu ion concentrations at the NIR lamp power density of 0.58 W/cm^2 and (b) The different NIR lamp power densities at 300 ppm of Cu ion concentration. All of the results were obtained triplicate.

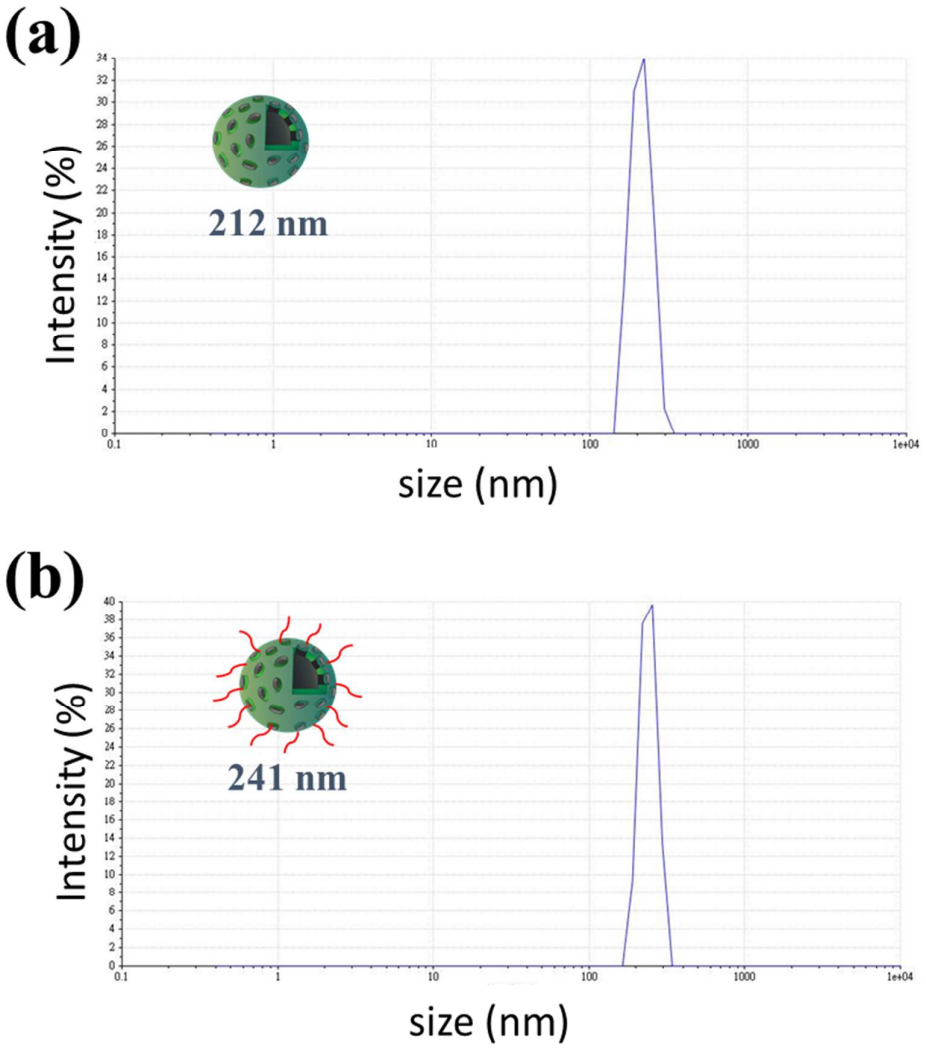

Figure S8. Measurements of the hydrodynamic diameters of the colloids. The hydrodynamic diameters of *h*-CuS/BC colloids (a) before and (b) after PEGylation.

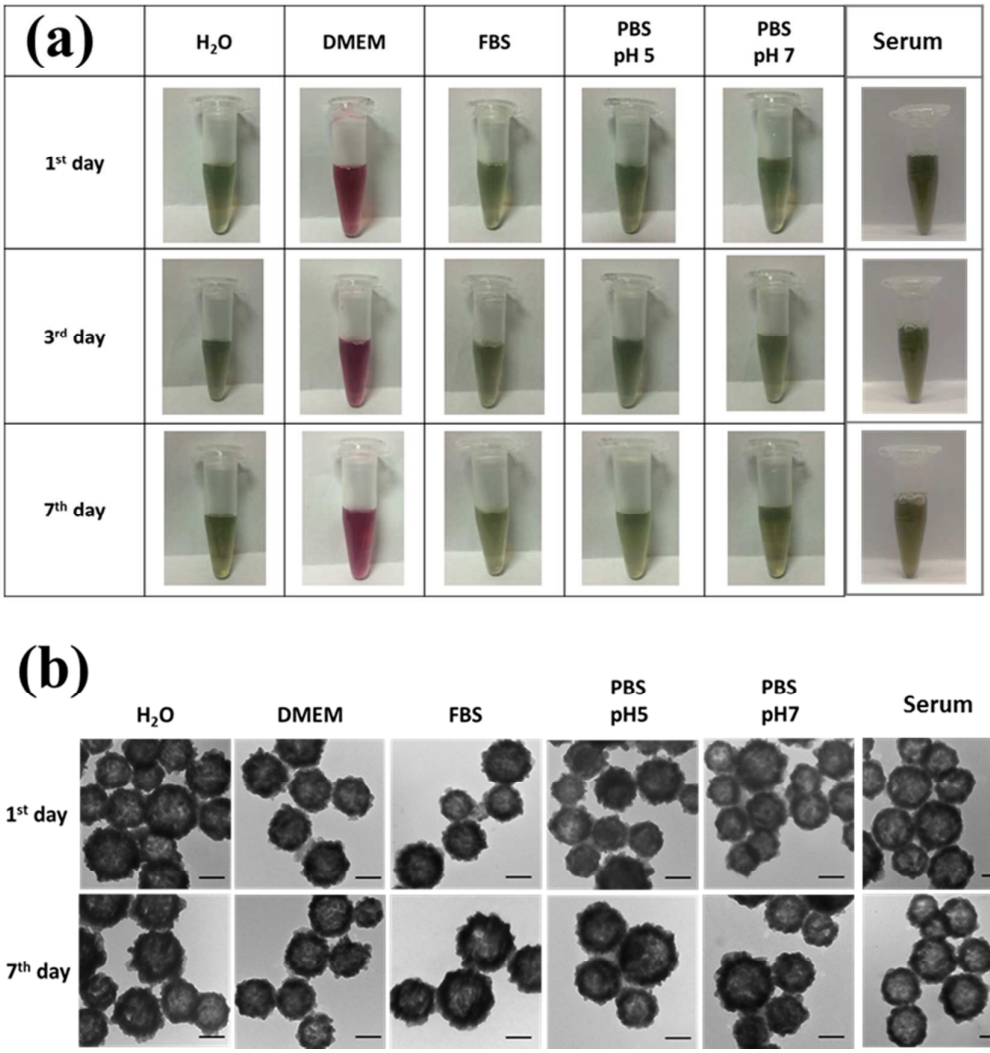

Figure S9. Stability performance of PEGylated *h*-CuS/BC colloids under different solutions. (a) PEGylated *h*-CuS/BC NPs can be well dispersed in H_2O, cells culture medium Dulbecco's modified Eagle's medium (DMEM) supplemented with 10% fetal bovine serum (FBS) and 1% penicillin/streptomycin, FBS, PBS (pH = 5.0), and PBS (pH = 7.0), and serum at 37 ºC for 7 days. (b) TEM images show the structural stability of the PEGylated *h*-CuS/BC NPs in different solutions on 1st day and 7th day. The scale bars were all set as 100 nm.

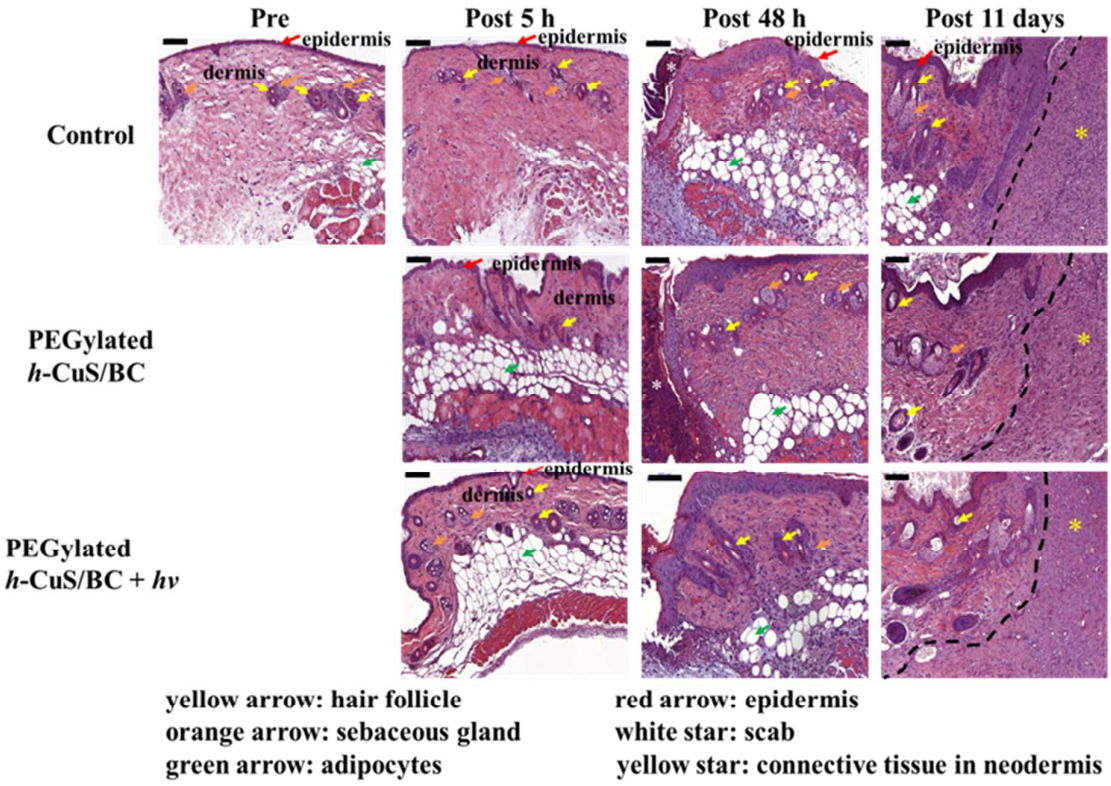

Figure S10. The hematoxylin and eosin (H&E) staining images as a function of time on wound sites. The wounds were treated with PBS as control, PEGylated *h*-CuS/BC colloids, and PEGylated *h*-CuS/BC colloids + NIR light. Wound healing after different treatments was examined on different time points. The neodermis (area under the dash lines) in the PEGylated *h*-CuS/BC colloids + NIR light treated mice expanded significantly on day 11 after wounding. Scale: 100 μm. Each data was evaluated from 3 mice studies.

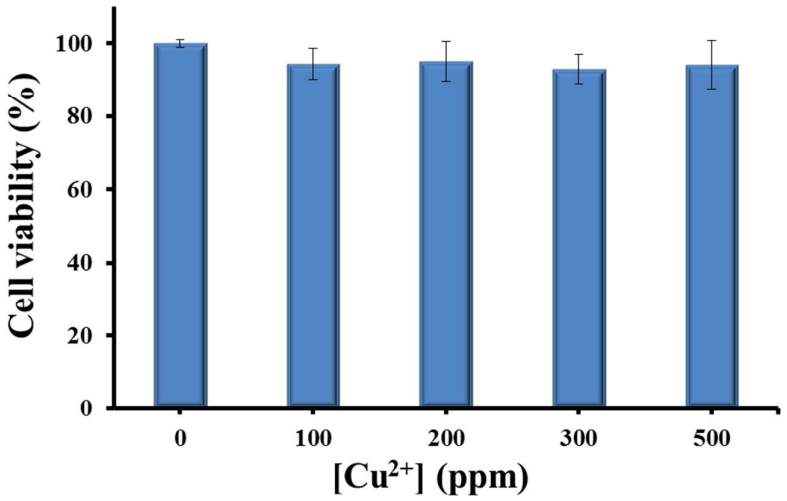

Figure S11. Cell viability for the MRC-5 cells treated with PEGylated *h*-CuS/BC colloids. All data are obtained in triplicate.

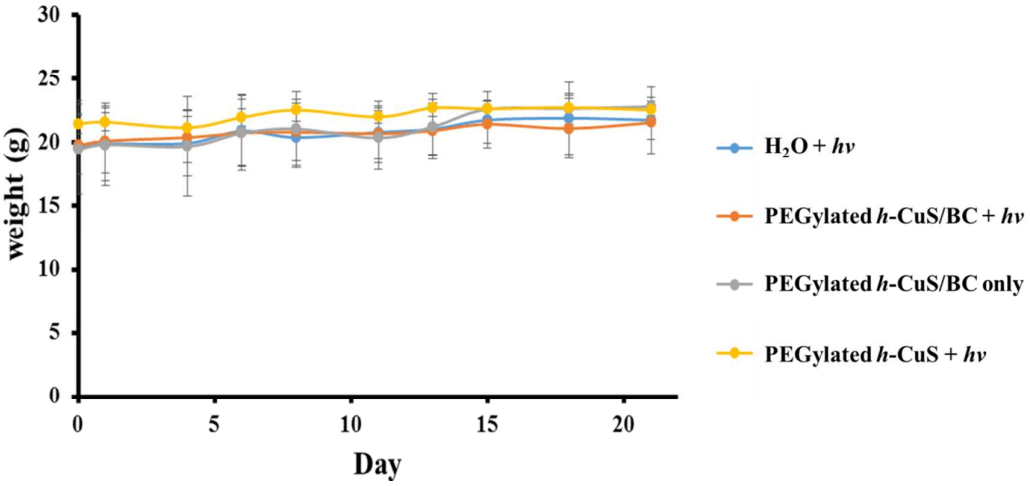

Figure S12. The body weights of the mice monitored for 21 days. The mice in all groups showed no weight loss (n=3). The 40 μL of PEGylated *h*-CuS/BC NPs at 300 ppm of copper ion concentration was dropped on the wound under different treatments.

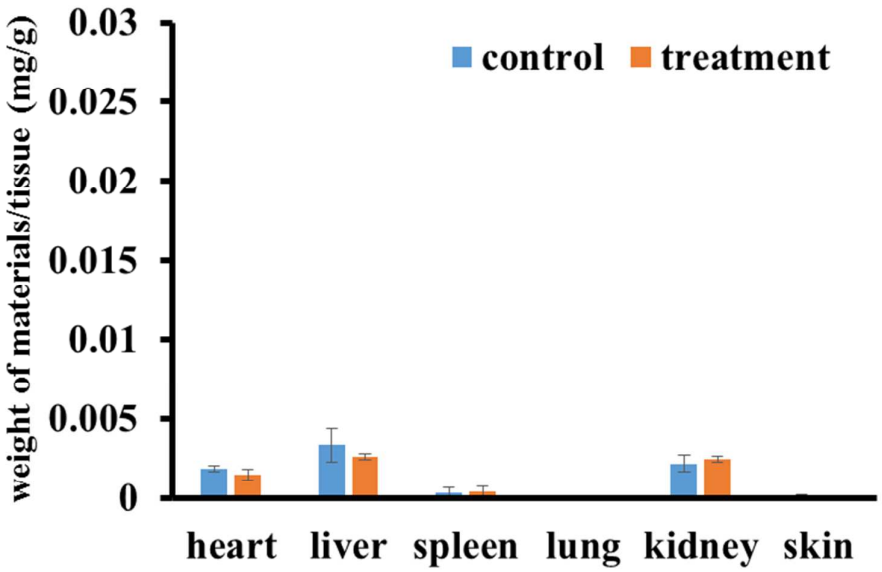

Figure S13. *In vivo* biodistribution for administration of PEGylated *h*-CuS/BC NPs and H_2O. The biodistribution was inspected after 21 days when the 40 μL of colloids (at 300 ppm of copper ion concentration) and H_2O were individually administrated on the wound receiving NIR lamp exposure of 5 min. The Cu content was determined by AA (n = 3) for different tissues monitored at 21th day. The skin tissues were collected on the wound position.

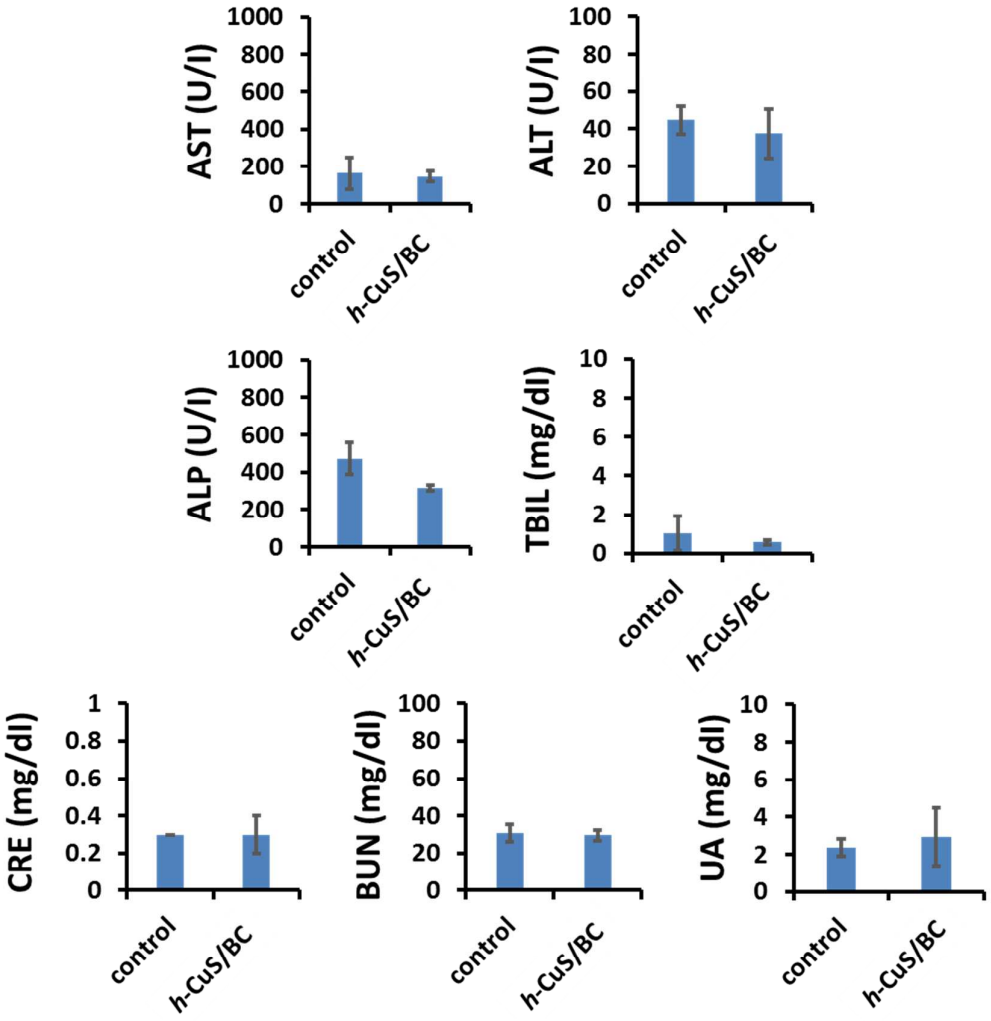

Figure S14. The intravenous injection of PEGylated *h*-CuS/BC colloids with dosage of 20 mg/kg to collect mice blood. Blood biochemical analysis after intravenous administration of 20 mg/kg of PEGylated *h*-CuS/BC NPs to mice was monitored on 21^{th} day in comparison with the healthy mice (AST: aspartate transaminase, ALT: alanine transaminase, ALP: alkaline phosphatase, TBIL: total bilirubin, CRE: creatinine, BUN: blood urea nitrogen, and UA: uric acid, n = 3).

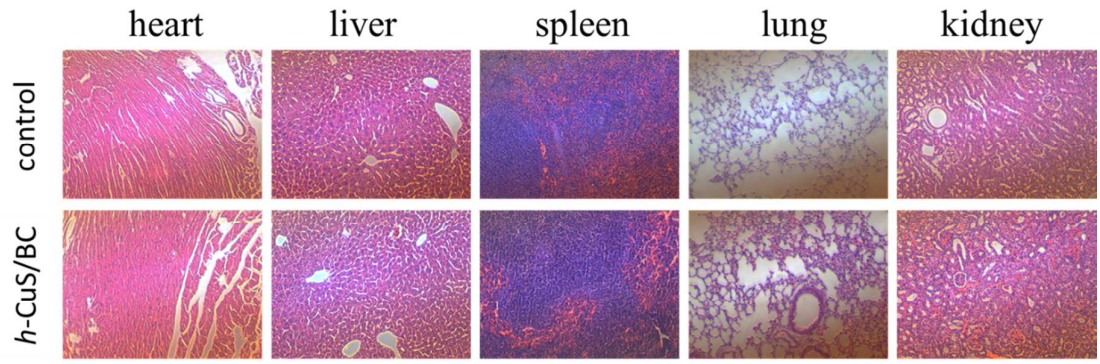

Figure S15. The intravenous injection of PEGylated *h*-CuS/BC colloids with dosage of 20 mg/kg for the hematoxylin and eosin staining analysis. H&E stained tissue sections shown for the organ tissues (heart, liver, spleen, lung, and kidney) from the mice treated with intravenous injection of PEGylated *h*-CuS/BC colloids (20 mg/kg) on 21th day in comparison with the healthy mice. Each data was evaluated from 3 mice studies.