Supporting information

1. Experimental details

1.1. Preparation of RSF

The degummed silk fibroin was prepared by immersing the silkworm cocoons in 0.5% Na_2CO_3 solution and boiled for 30 min for three times. Then, the obtained regenerated silk fibroin (RSF) was rinsed thoroughly with deionized water to remove the residual sericin. After drying (60 ℃, 6 h), the degummed RSF was dissolved in a ternary solution of $CaCl_2$: CH_3CH_2OH: H_2O (v/v/v = 1:2:8) at 60 °C for 3 h, and then, the insoluble impurities were removed by centrifugation (7000 *g*, 10 min). Subsequently, a clear desalted RSF solution was obtained after dialysis for three days.

RSF solution (10 mL, 4%) was dropped into the plate and dried in a vacuum drying oven (42 ℃, 100 mb). The RSF film was obtained and taken out after completely drying. Subsequently, the RSF film was annealed (60 ℃, 500 mb) for 4 h. Finally, the RSF film was observed whether it dissolved in water.

1. 2. Cell adhesion assay

The RSF film was cut into the same size as the 12-well plate and put into the 12-well plate for UV irradiation for 2 h. The perforated plate without any treatment was used as the control group, while 3M Transparent Dressing and RSF film were used as the experimental group, with 3 parallel groups in each group. Each well was inoculated with 1.0×10^5 cells/well and incubated overnight. After that, the cells were washed with PBS containing calcium and magnesium for 3 times, and fixed with paraformaldehyde for 30 min. After being fixed, the cells were soaked with 1% Triton for 10 minutes, then

washed with PBS for 2 times, and soaked with 1% BSA for 30 minutes, then washed with PBS for 2 times. Finally, 500 μL Actin-Tracker Red-555 dye was added and stained for 1 h, and then 500 μL DAPI was added and strained for 10 minutes. Finally, anti-fluorescent agent was added for confocal photography.

1.3. Biocompatibility assay of RSF films

The biocompatibility of RSF films was evaluated by using the leach liquor. Firstly, the RSF film was immersed in DMEM medium containing antibiotics for 12 h and the supernatant was collected. Then, L929 fibroblasts were seeded into a 96-well plate at a density of 1.0×10^4 cells/well. After incubated in a 5% CO_2 incubator at 37 ℃ for 24 h, the original culture medium was discarded. RSF films leach liquor was added to DMEM medium (containing 10% fetal bovine serum and 1% antibiotics) with a concentration of 100 μL per well. After 24 h, 50 μL MTT solution (0.5 mg /mL) was added, and then 50 μL DMSO solution was added for incubation of 4 h. Finally, the OD value of cell suspension was measured at a wavelength of 570 nm.

1.4. Physicochemical characterization of CaO_2-Cu_2O micromotors

The dynamic light scattering instrument (DLS, Brooke, Billerica, USA) was used to measure the mean fluid volume dynamic diameter and the possessed polydispersity index (PDI) of various micro-particles. The crystalline state of micromotors was analyzed by X-Ray Diffractometer (XRD, Brooke，Billerica，USA). Scanning electron microscope (SEM, Hitachi, Tokyo, Japan) was used to observe the morphologies of various particles. X-ray photoelectron spectroscopy (XPS, Thermo

Fisher, Massachusetts, USA) was applied to investigate the composition of CaO_2-Cu_2O micromotors.

1.5. Cytocompatibility of CaO_2-Cu_2O micromotors

The MTT assay was used to determine the biocompatibility of particles. Initially, L929 fibroblasts，RAW 264.7 macrophages，and HUVECs were seeded into 96-well plates with a density of 1.0×10^4 cells/well, and incubated overnight with complete medium. Then, cells were washed three times with PBS, and medium with various particles (200 μL, 100 μg/mL) was respectively added to each well for incubation of 24 h. Subsequently, the cells were incubated with MTT solution (100 μL, 0.5 mg/mL) for 4 h at 37 ℃, and DMSO (50 μL) was added to each well to test the OD value at a wavelength of 570 nm. Cells without treatment were utilized as the negative control, and Triton X-100 (1%, w/v)-treated cells were used as the positive control.

1.6. Permeation capacity of CaO_2-Cu_2O micromotors

Hydroxyethyl cellulose (HEC) hydrogel (100 μL, 5 w/v %) was transferred to 96-well plate to simulate the wound tissue with strong resistance for permeation. CaO_2-Cu_2O micromotors conjugated with coumarin (2.5 w/v%, 50 μL) were added on the top of HEC hydrogel. Five minutes later, the HEC hydrogels were layer by layer scanned (10 μm/layer) by super-resolution laser scanning confocal microscopy (SRLSCM, Olympus Corporation, Tokyo, Japan) to create the 3D view. The polystyrene (PS) microspheres conjugated with rhodamine were set as the control group (2.5 w/v%, 50 μL).

1.7. In vitro cell migration

L929 fibroblasts and HUVECs were inoculated in 6-well plates with a density of 1.0×10^6 cells/well, respectively. After overnight incubation, scratches were produced by scraping the monolayer of cells with a pipet tip. Subsequently, cells were washed and incubated with various particle suspensions. The regrowth of the 'wounded' areas was measured as a function of time from 0 to 48 h. Finally, the scratch area was quantified by Image J Software.

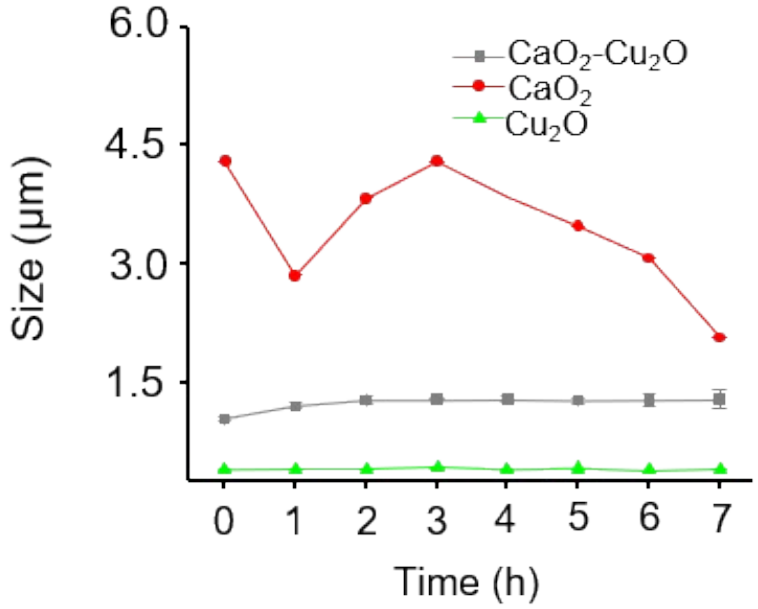

Fig. S1. Size variation of CaO_2, Cu_2O and CaO_2-Cu_2O micromotors at different time points.

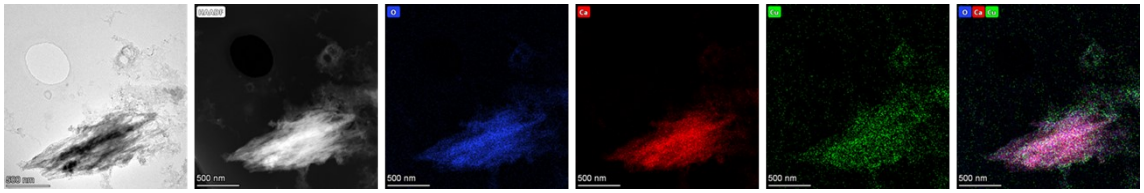

Fig. S2. EDS mapping image and elemental mapping for CaO_2-Cu_2O micromotors. Scale bar = 500 nm.

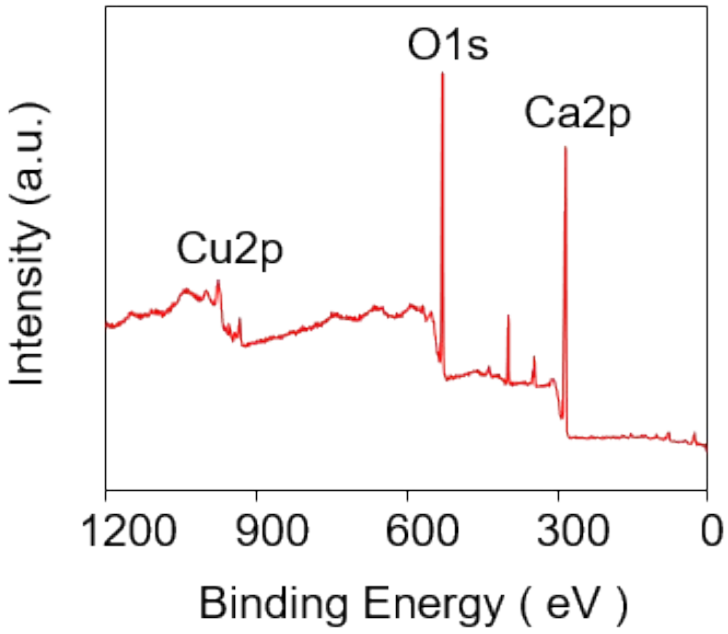

Fig. S3. X-ray photoelectron spectroscopy (XPS) survey spectrum of CaO_2-Cu_2O micromotors.

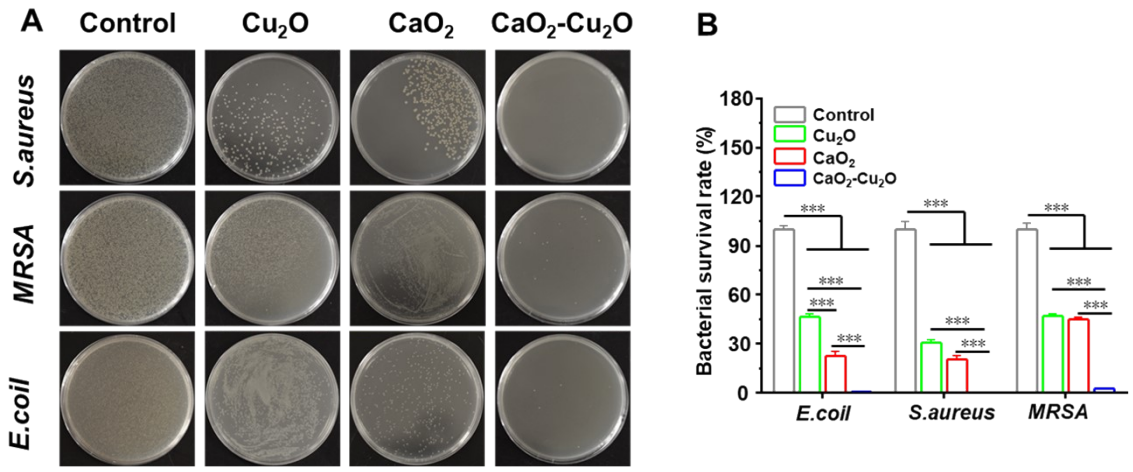

Fig. S4. Bactericidal efficiencies of CaO_2, Cu_2O and CaO_2-Cu_2O.

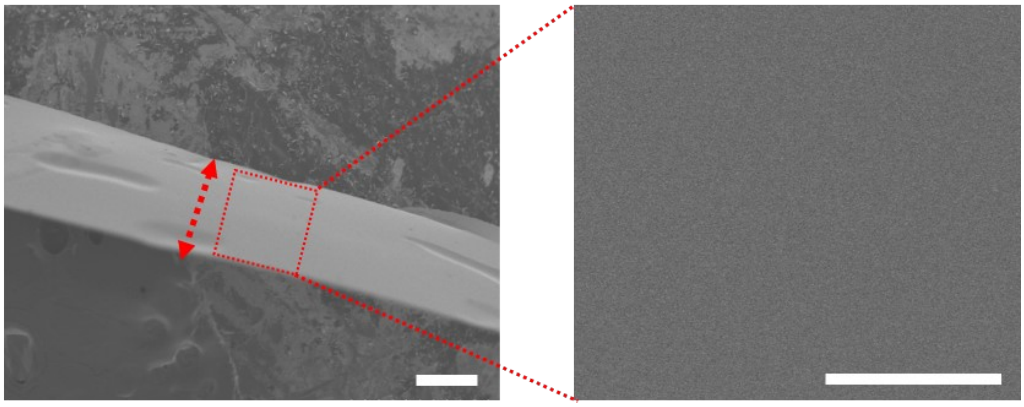

Fig. S5. SEM image of section of **the** RSF film. Scale bars=200 μm.

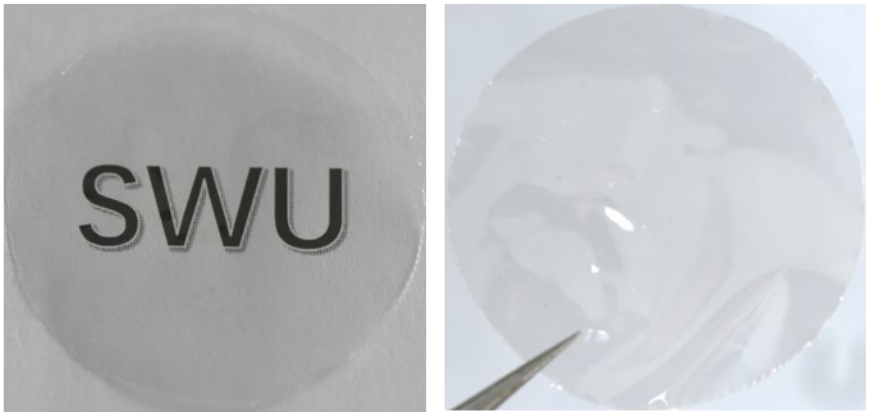

Fig. S6. Transparency of the RSF film.

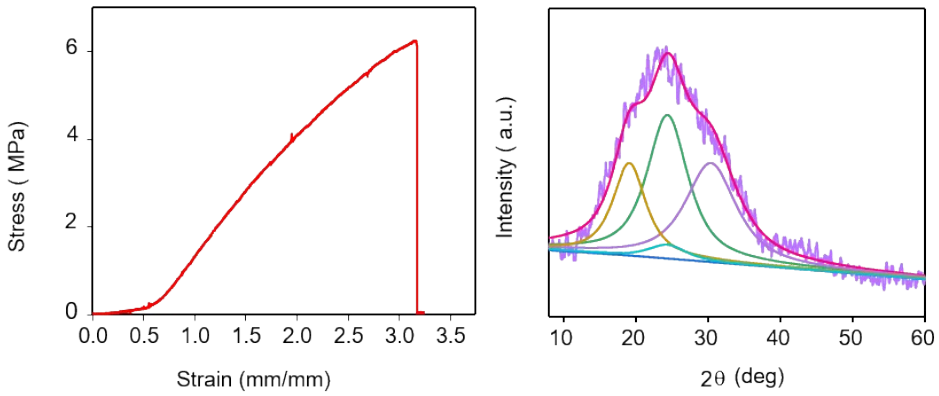

Fig. S7. Mechanical properties and XRD patterns of the RSF film.

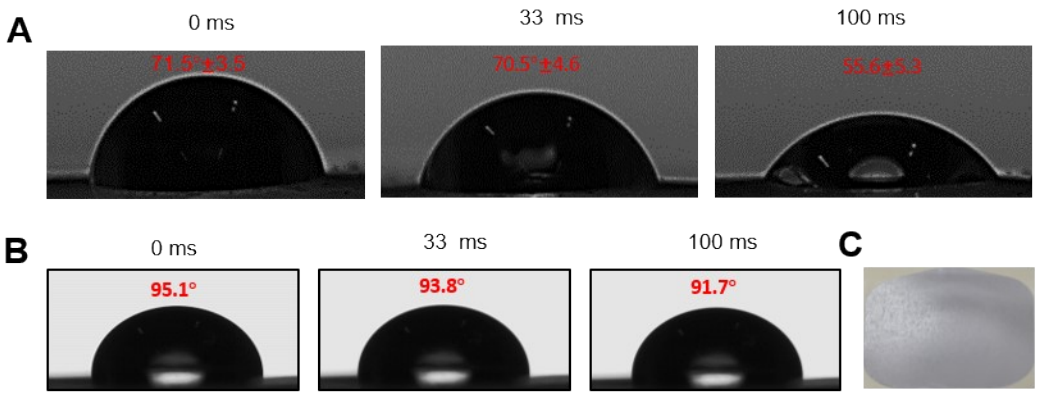

Fig. S8. Contact angel for water of the RSF film and 3M Transparent Dressing.

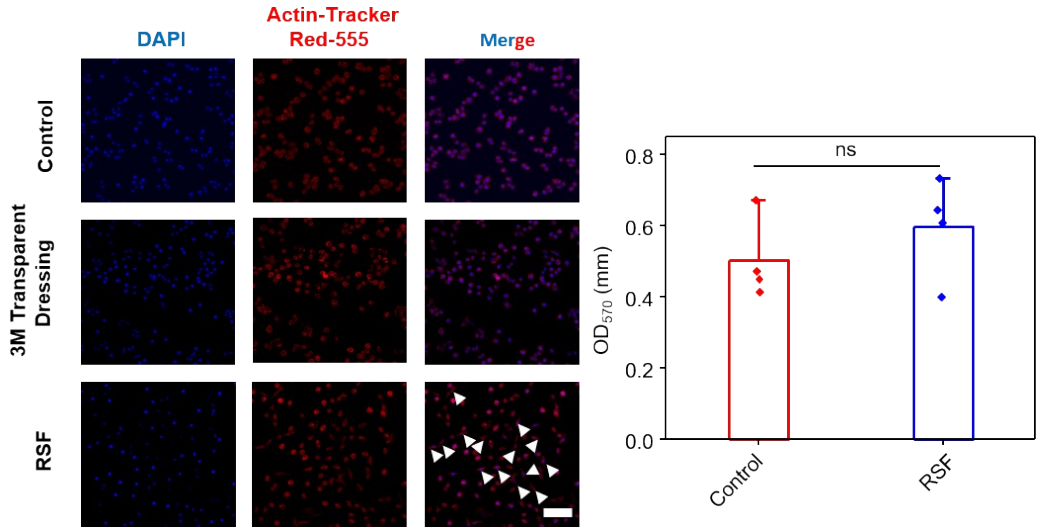

Fig. S9. Cell adhesion assay of **3**M Transparent Dressing and the RSF film. Scale bar = 200 μm.

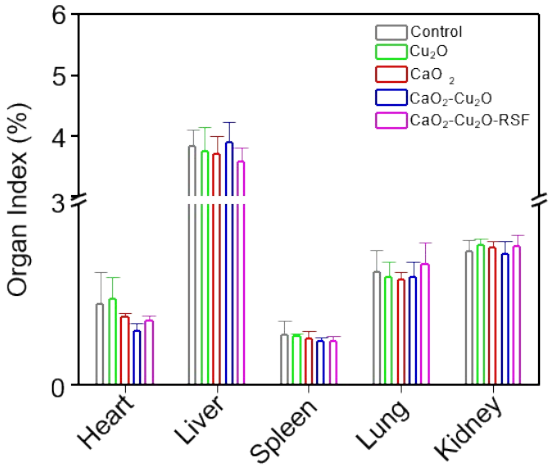

Fig. S10. Organ indexes of different experimental groups.

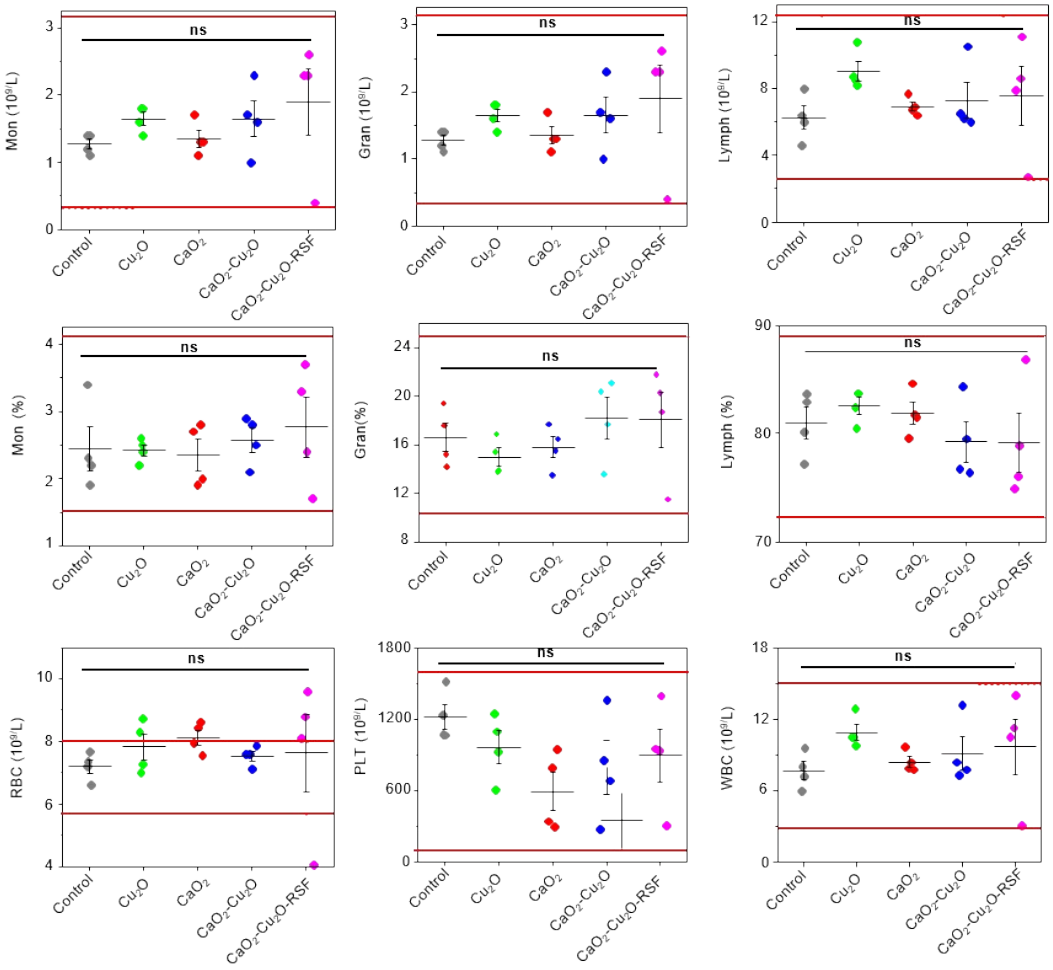

Fig. S11. Blood routine index of different groups.

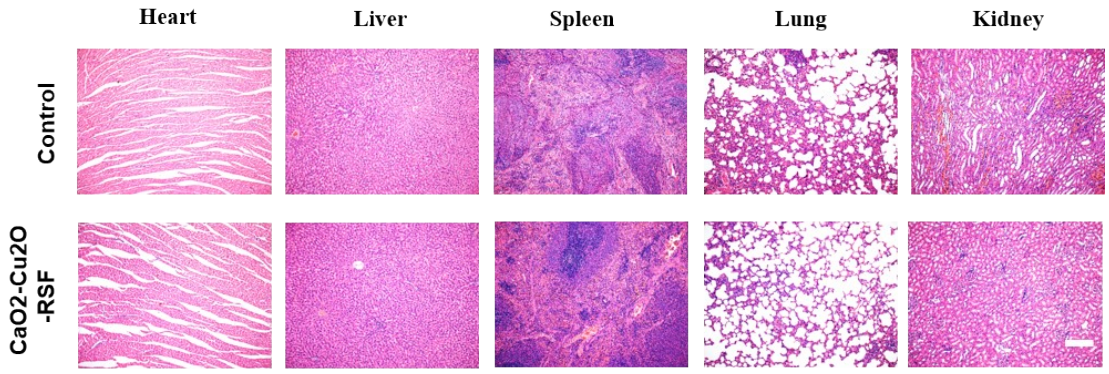

Fig. S12. H&E staining of major organs (heart, liver, spleen, lungs and kidneys) of rats on day 14 in wound healing experiments. Scale bars = 200 μm.