Electronic Supplementary Material (ESI) for RSC Advances.


# "Less Blue, More Clean": $Cu_2O$ Nano-cubic Functionalized Hydrogel for the Harmful Energy Transformation of Light-emitting Screen

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**Statistical analysis.** After testing CMHG film (1mm) by UV-Vis spectrometer (UV-2550, Shimadzu), we got a relationship between wavelenth and transmittance of the data. Then the data was imported into UV Probe 2.33 to calculate AUC of blue light absorbance ($s_1$) and visible light transmittance ($s_2$). Following the procedure, the average value of blue light absorbance (A%) and visible light transmittance (T%) should be calculated using equation (1) and (2) (Table S1). Next, six black points would be drawn by using A% and six red points was also drawn by using T% shown in Fig 3c. There were four equations, including quadratic equation, S-Curve equation, exponential function and logistic equation, which would be used to fitted the black points and the red points. Comparing with R, the black points was fitted by S-Curve equation and the red points was fitted by Quadration equation (Table S2). For another evaluation, Savitzky-Golay was used for calculated for smooth curve, by using MATLAB (Fig 3d).

$$(1)\ A\% = 100 - \frac{s_1}{\lambda_{\max} - \lambda_{\min}} \times 100\%$$

$$(2)\ T\% = \frac{s_2}{\lambda_{\max} - \lambda_{\min}} \times 100\%$$

**Antibacterial property testing.** Antimicrobial activity of HG and CMHG were determined using similar Spread Plate Method had be added to guide the authors. The average initial microbial culture (*Escherichia coli and Staphylococcus aureus*) concentration was $2\times10^8$ CFU/ml. A volum of 200ul of bacterial solution was added to the separate flasks under gentle shaking. Until the bacterium was fully covered, each flasks was coated by HG or CMHG. Then the flasks were incubated and irradiated under blue light at 37 °C for 1 h. After a series of dilutions of the bacterial solutions, 50 μl of the solution taking from the dilution of 5ml was plated in nutrient agar. The nutrient agar was incubated at 37 °C for 6 h and surviving bacterium were counted.

**Cytotoxicity studies.** To evaluate the influence of CMHG(15.0mg/ml), Cu2O NPs(15.0mg/ml), ZnO NPs(15.0mg/ml) and CMHG(7.5mg/ml) on the cellular viability; Cells(293T cells) were seeded and cultured at a density of 5×103 cells per well in 96-well plates prior to treatment. Following incubation for 24 h in a humidified incubator (95% air and 5% CO2) at 37°C, 10 μl the sample was added to each well. After 6 h incubation at 37°C, 10 μl CCK-8 reagent was added to each well. The cells were incubated for 2 h at 37 °C to ensure complete dissolution of the whole well, absorbance was measured at 450 nm.

**Skin toxicity research**. To evaluate the skin toxicity of CMHG, KM mice at 8 weeks of age were purchased. The mouse back skin was shaved and washed by PBS buffer before the experiments. A group of mouse was only treated with PBS buffer, which served as a blank control, another group of mouse was treated with HG, and the rest was treated with CMHG. After the last topical administration, the mice were killed and the skin was cross-sectioned by 7mm thick for histological examination. The skin biopsies from each group were stored in 10% formalin for 18h. A series of machine were used in hematoxylin and eosin(H&E), such as Frozen Section Machine(HM525, Germany), Inversed Fluorescent Microscope(DM13000B, Leica).

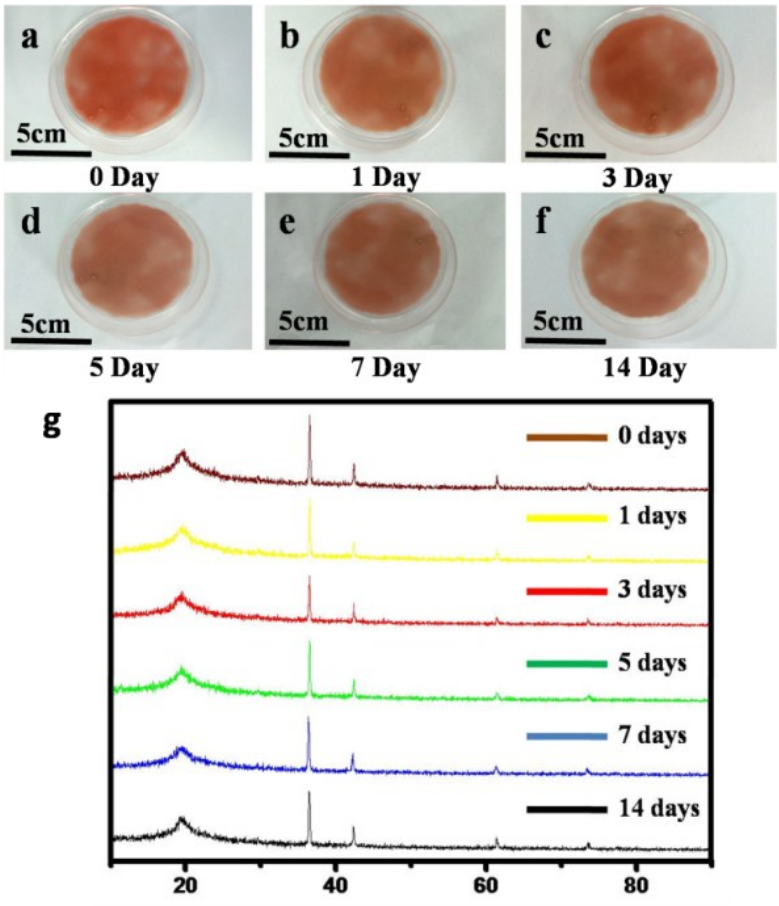


**Fig S1.** Photos of CMHG film exposed in air were recorded on 0 day(a), 1 day(b), 3 day(c), 5 day(d), 7 day(e) and 14 day(f); recorded by XRD on 0 day, 1 day, 3 day, 5 day, 7 day, and 14 day(g).

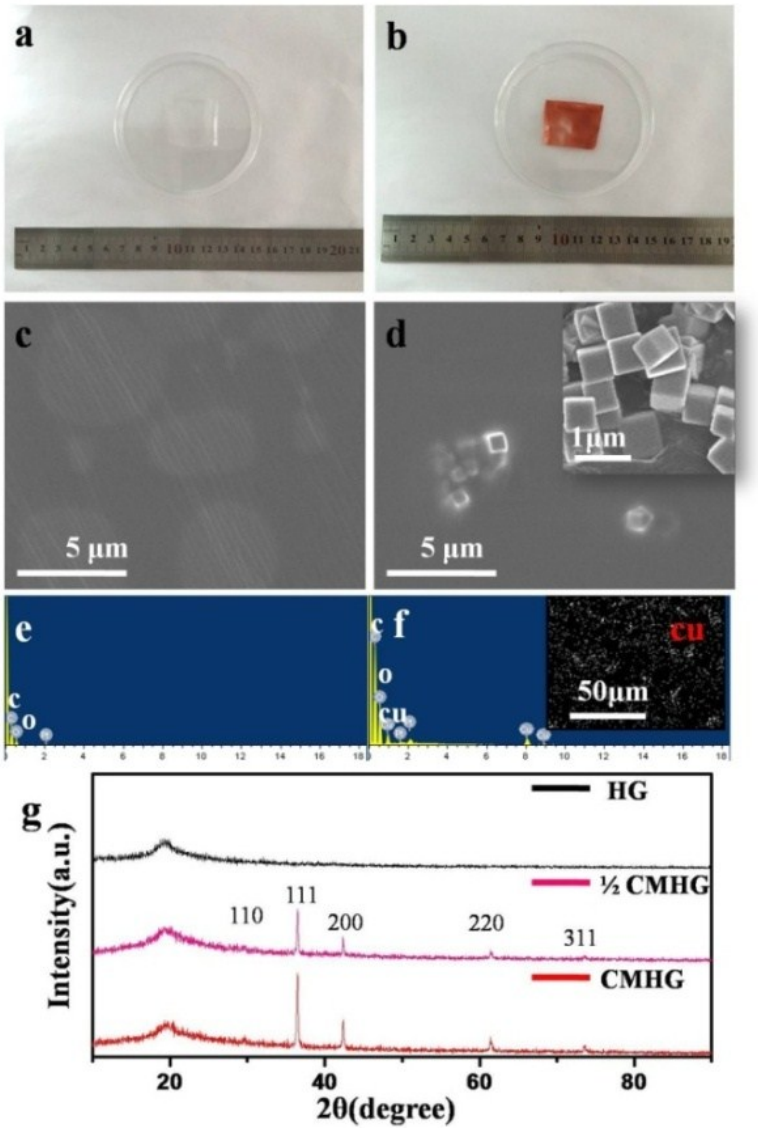


**Fig S2.** Photos of HG film(a), and CMHG film(b);SEM images of HG film at 5000×(c), CMHG film at 5000× and the interpolated image indicating $Cu_2O$ NPs(d), Energy Dispersive Spectrometer(EDS) scanning for HG film(e) and CMHG film(f); Wide-angle XRD analysis for HG film, ½CMPC film and CMPC film(g) (CMHG: 50.0mg in 2ml HG,½CMPC: 25.0mg in 2ml HG).

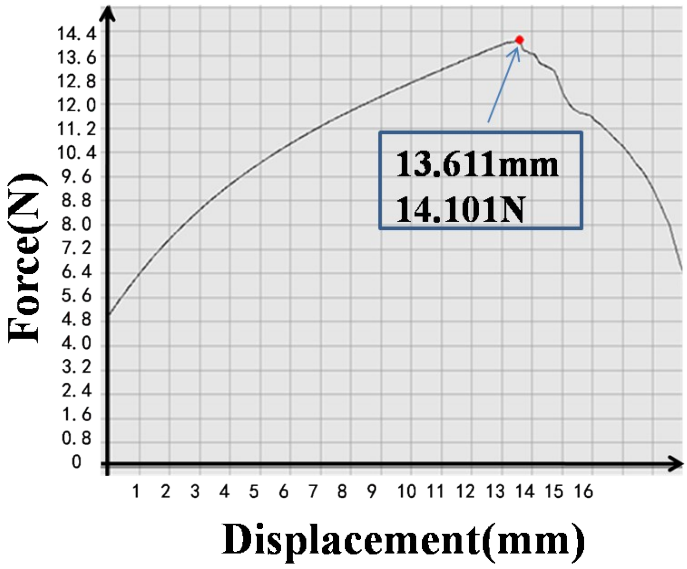


**Fig S3.** Mechanical strength test of the CMHG film (40 mm x 25 mm x 1 mm), the maximum bearing capacity was shown at the red point.

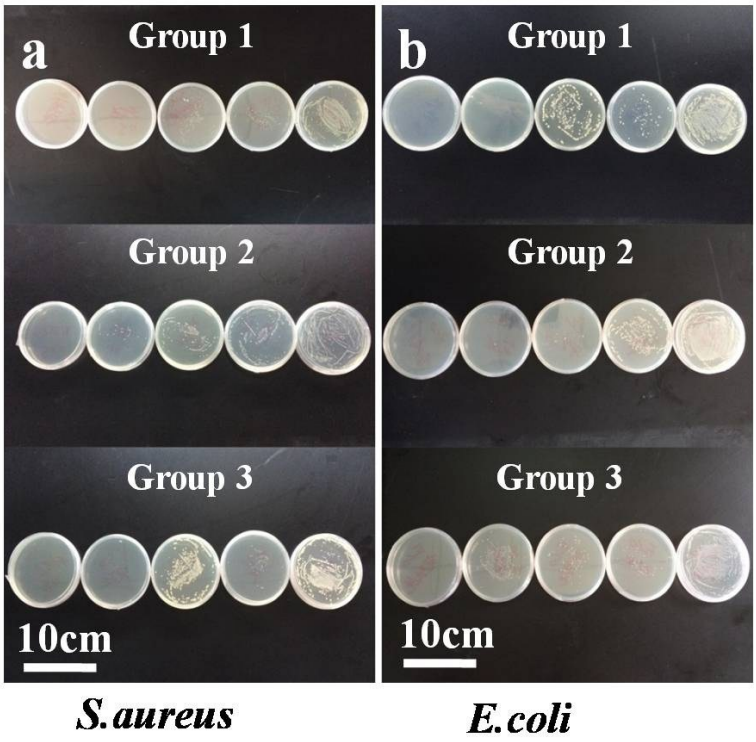

**Fig S4.** Results of antibacterial experiments for *S.aureus*(a) and *E.coli*(b).(n=3)

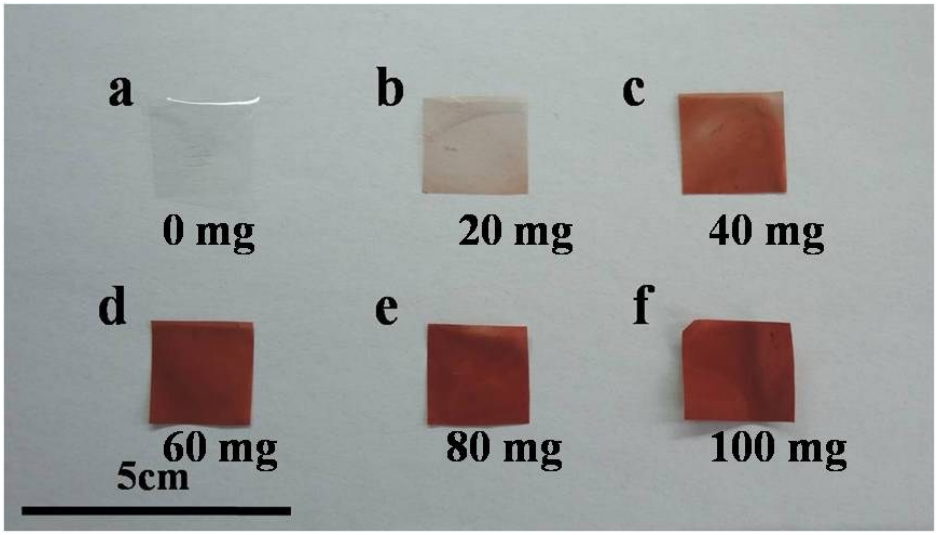


**Fig S5.** Photos of CMHG film with different concentration of polymer-functionalized cubic $Cu_2O$ NPs 0 mg(a), 20 mg(b), 40 mg(c), 60 mg(d), 80 mg(e), 100 mg(f) per 2 ml HG.

| **Weight of $Cu_2O$ per 2ml HG** | **Area under the curve(AUC)** | | **The average of absorbance and transmittance** | |
|---|---|---|---|---|
| Weight (mg) | Blue light transmittance $S_1(nm)_{[a]}$ | visible light transmittance $S_2(nm)_{[a]}$ | Blue light absorbance $A\%_{[b]}$ | visible light transmittance $T\%_{[b]}$ |
| 0 | 92.129 | 276.264 | 7.871 | 92.088 |
| 20 | 73.626 | 246.441 | 26.374 | 82.147 |
| 40 | 11.238 | 116.065 | 88.762 | 38.688 |
| 60 | 5.851 | 98.468 | 94.149 | 32.823 |
| 80 | 4.495 | 87.877 | 95.505 | 29.292 |
| 100 | 2.773 | 69.910 | 97.227 | 23.303 |

**Table S1.** [a] AUC was calculated by UVProbe 2.33, blue light wavelength (400-500 nm), visible light wavelength (400-700 nm).

[b] $A\% = 100 - \frac{S_1}{\lambda_{max} - \lambda_{min}} \times 100\%$ $T\% = \frac{S_2}{\lambda_{max} - \lambda_{min}} \times 100\%$

a

| Equation | Sample | | | | | Parameter estimate | | |
|---|---|---|---|---|---|---|---|---|
| | R | F | df1 | df2 | Sig. | $b_0$ | $b_1$ | $b_2$ |
| Quadration | 0.928 | 19.465 | 2 | 3 | 0.019 | -52.313 | 59.849 | -5.858 |
| S-Curve | 0.952 | 79.205 | 1 | 4 | 0.001 | 5.241 | -3.241 | - |
| Exponential | 0.717 | 10.126 | 1 | 4 | 0.033 | 9.662 | 0.471 | - |
| Logistic | 0.717 | 10.126 | 1 | 4 | 0.033 | 0.103 | 0.624 | - |

b

| Equation | Sample | | | | | Parameter estimate | | |
|---|---|---|---|---|---|---|---|---|
| | R | F | df1 | df2 | Sig. | $b_0$ | $b_1$ | $b_2$ |
| Quadration | 0.933 | 20.814 | 2 | 3 | 0.017 | 130.471 | -36.958 | 3.205 |
| S-Curve | 0.789 | 14.957 | 1 | 4 | 0.018 | 3.111 | 1.606 | - |
| Exponential | 0.913 | 41.904 | 1 | 4 | 0.003 | 119.126 | -0.289 | - |
| Logistic | 0.913 | 41.904 | 1 | 4 | 0.003 | 0.008 | 1.336 | - |

**Table S2.** Analysis results of quadratic equation, S-Curve equation, exponential function and logistic equation for blue light absorption (a) and visible light transmittance. All above data were calculated by SPSS(b). R: It express the degree of linear correlation among variables, which is generally expressed by R. The bigger the |r| value, the better the correlation（$0 \leqslant |r| \leqslant 1$）; F: The results of the F-test for the model; df1: Number of samples; df2: Number of variables; Sig.: It is the probability value of the F-test.

**Movie S1.**The touch control experience of the screen through CMHG.