Supporting Information

Retinal-inspired flexible photosensitive arrays based on selective photothermal conversion

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1. Synthesis of nanoparticles

Materials: Ascorbic acid (AA), cetyltrimethylammonium bromide (CTAB) were purchased from Shanghai Sinopharm Chemical Reagent Co., Ltd. (China). Hydrogen tetrachloroaurate tetrahydrate ($HAuCl_4 \cdot 4H_2O$) and cetyltrimethylammonium chloride (CTAC) were purchased from Energy Chemical. Sodium oleate (NaOL) was purchased from Aladdin Industrial Corporation. And hydrochloric acid (HCl, 37 wt% in water) was purchased from Beijing Chemical Works. All the glassware was cleaned by aqua regia (HCl:HNO_3 in a 3:1 ratio by volume) and rinsed with deionized water prior to the experiments.

Synthesis of Au NR: The seed solution for Au NR growth was prepared as follows: 5.0 mL of 0.5 mM $HAuCl_4$ was mixed with 5.0 mL (0.2 M) CTAB solution in a 20 mL glass vial. 0.6 mL (0.01 M) fresh $NaBH_4$ was diluted to 1.0 mL water and then injected to the mixed solution under vigorous stirring. The color of solution changed from yellow to brownish yellow and the stirring was stopped after 2 min. The seed solution was aged at room temperature for 30 min before use.

To prepare the growth solution, 0.70 g CTAB and 0.12 g NaOL were dissolved in 25.0 mL warm water (60 °C) with a 100 mL round-bottom flask. The solution cooled down to 30 °C and was added with $AgNO_3$ solution (0.01M, 0.37 mL). The mixture was kept undisturbed at 30 °C for 15 min after 25 mL of 1 mM $HAuCl_4$ solution was added. The solution was stirring for 90 min. Then, 0.15 mL HCl (37 wt. % in water, 12.1 M) was introduced. After another 15-min slow stirring, 0.125 mL 0.064 M AA was added and the solution was vigorously stirred for 30 s. Finally, 40 uL seed solution

was injected into the growth solution. The resultant mixture was stirred for 30 s and left undisturbed at 30°C for 12 h for NR growth.

Synthesis of Au NS: The seed solution for Au NS growth was prepared as follows: A fresh aqueous $NaBH_4$ solution (0.01 M, 0.6 mL) was rapidly added into a thoroughly mixed 10 mL aqueous solution containing $HAuCl_4$ (0.25×10^{-3} M) and CTAB (0.1 M). Then the mixture was stirred for 2 min, and kept undisturbed at 27 °C for 3 h to ensure complete decomposition of $NaBH_4$.

Then, aqueous solutions of CTAC (0.2 M, 20 mL), AA (0.1 M, 15 mL), and the seed solution (500 uL) were mixed in a round-bottom flask, followed by one-shot injection of an aqueous $HAuCl_4$ solution (0.5×10^{-3} M, 2 mL). The reaction was allowed to continue at 27 °C for 15 min under stirring.

Synthesis of Ag NS: 20 mL (1% (w/v)) sodium citrate solution and 75 mL water were added in a round bottom flask and the mixture was heated to 70 °C for 15 min. After that, 1.7 mL (1% (w/v)) $AgNO_3$ solution was introduced to the mixture, followed by the quick addition of 2 mL (0.1% (w/v)) freshly prepared $NaBH_4$ solution. The reaction solution was kept at 70 °C under vigorous stirring for 1 h and cooled to room temperature.

2. Details of the measurements

Instrument: The light source used is a MS3081+ digital projector (BenQ Co., Ltd). Resistance response data were measured by using a CHI760e electrochemical workstation (Shanghai CH instrument Co., Ltd.). Thermal response were measured by UT 325 digital thermometers (UNI-T Technology (China) Co., Ltd.). Thermal images were taken by IR-384 thermal infrared imager (RNO).

Preparation of light-sensitive arrays: A square PDMS with dimensions of 5.6×5.6×0.4 cm was prepared. An array of 4×4 holes was punched uniformly on the PDMS with a 0.7 cm inner diameter punch. The hole spacing is 0.7 cm, and the distance between the peripheral holes and the edge of PDMS is 0.35 cm. Similarly, take transparent double-sided tape and punch the same size array of holes. Then glue the perforated double-sided tape on the top and bottom of the PDMS. Finally, use syringe to inject the nanoparticle solutions into the PDMS holes and ensure that each 2×2 array forms a pixel dot.

Construction of resistance response test set-up: Place the projector on top of the photosensitive array and set a len at the projector's light-emitting port. Make the array just covered by light by adjusting the elevation table. Connect the ITO on the array to a relay through wires, and then connect the relay to CHI760e electrochemical workstatio.

3. Calculation

After substituting the value of resistance responses and the corresponding N' obtained by the function f into equation (4), the specific value of the photosensitive coefficient matrix P can be calculated, as shown in equation (S1). Then, the value of P^{-1} can be easily calculated by performing the inverse operation on the matrix P. And the specific values of P^{-1} are shown in equation (S2).

$$\begin{bmatrix} x_{Au\,NR} & y_{Au\,NR} & z_{Au\,NR} \\ x_{Au\,NS} & y_{Au\,NS} & z_{Au\,NS} \\ x_{Ag\,NS} & y_{Ag\,NP} & z_{Ag\,NS} \end{bmatrix} = \begin{bmatrix} 0.30 & 2.33 & 2.97 \\ 0.23 & 4.00 & 5.21 \\ 0.65 & 4.20 & 8.00 \end{bmatrix} \quad (S1)$$

$$P^{-1} = \begin{bmatrix} 5.54 & -3.41 & 0.17 \\ 0.87 & 0.25 & -0.49 \\ -0.91 & 0.15 & 0.37 \end{bmatrix} \quad (S2)$$

4. Data Section

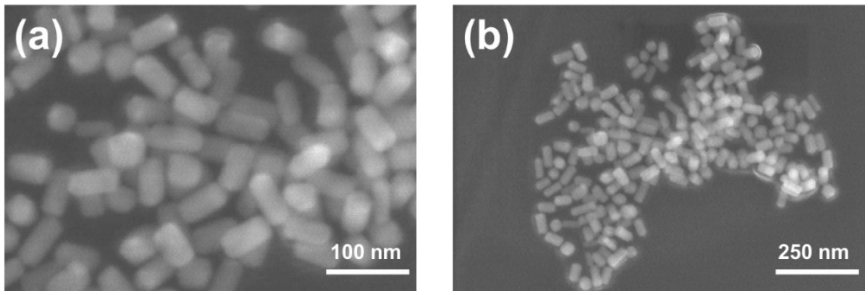

Figure S1. (a)(b) The SEM images of the Au NR.

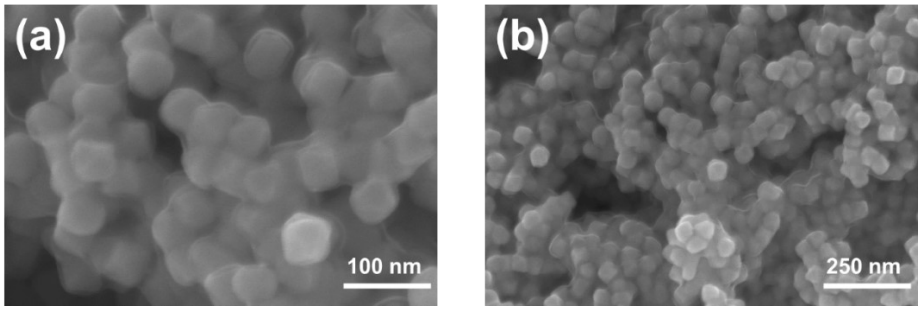

Figure S2. (a)(b) The SEM images of the Au NS.

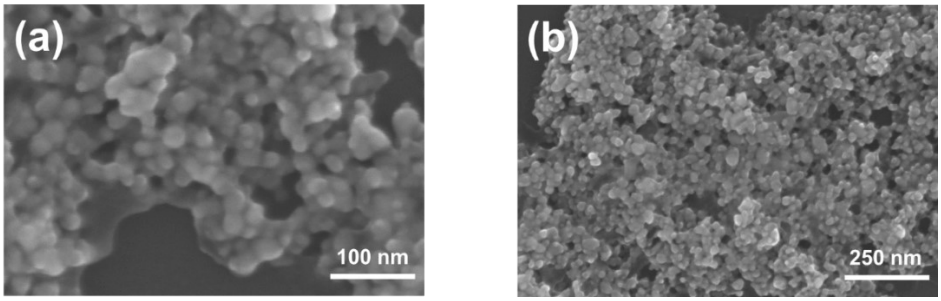

Figure S3. (a)(b) The SEM images of the Ag NS.

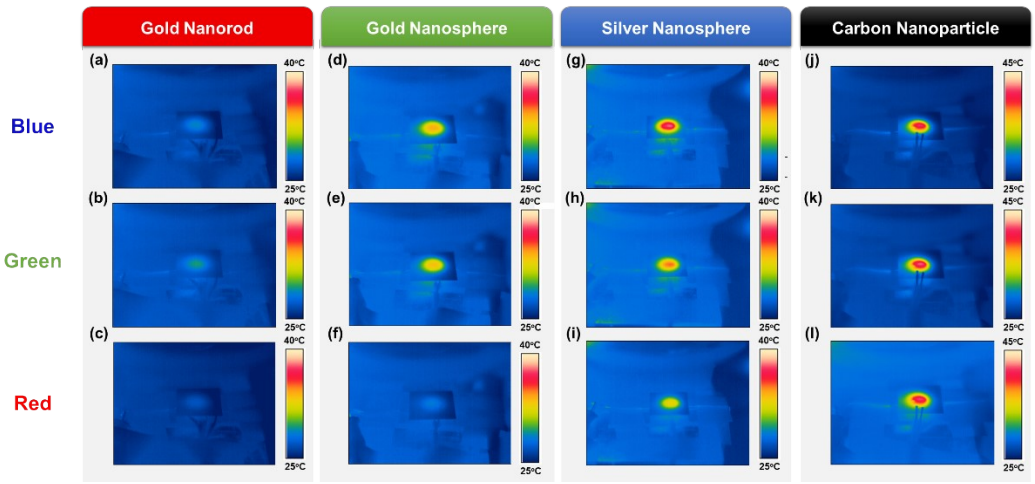

Figure S4. Thermal images taken from the chips of Au NR (a-c) , Au NS (d-f) , Ag NS (g-i) , C NP (j-l) solutions under the irradiation of red (N_r=255), green (N_g=255) and blue (N_b=255) lights for 5 min.

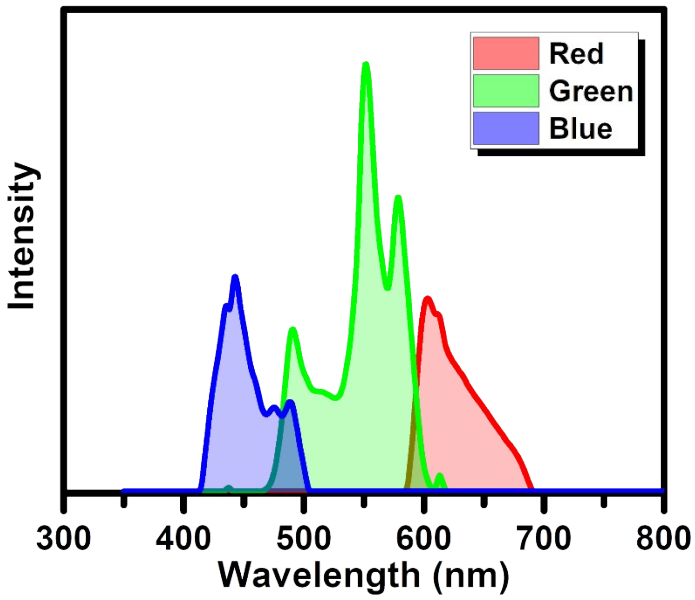

Figure S5. Spectrum of projector light.

Table S1. Photothermal conversion efficiencies ratios of nanoparticles for light with different colors

	η_r	η_g	η_b
Au NR	0.748	1.000	0.777
Au NS	0.677	1.000	0.691
Ag NS	0.973	0.858	1.000
C NP	1.000	0.844	0.791

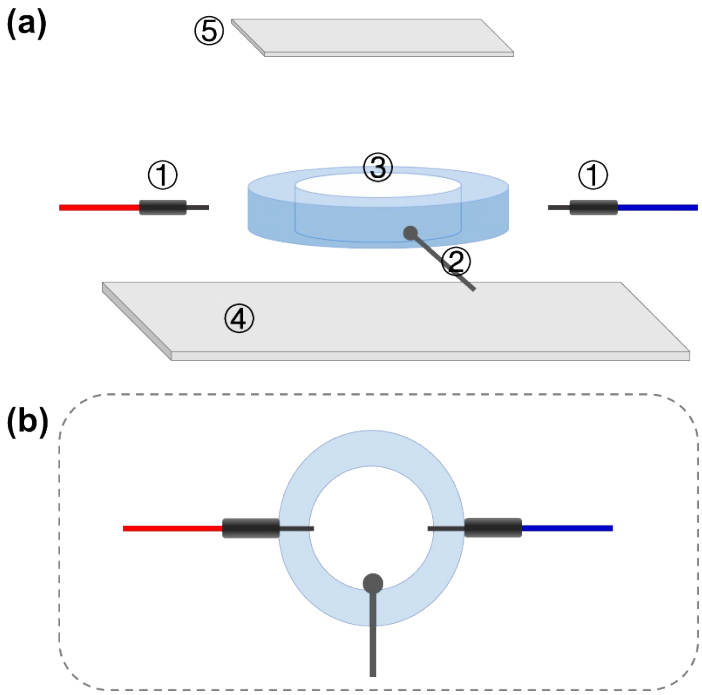

Figure S6. (a) Schematic fabrication of the circular chamber. ① electrodes connecting the nanoparticle solutions with the electrochemical workstation; ② temperature probe; ③ PDMS ring; ④ slide glass; ⑤ cover slide glass. (b) top view of the completed chamber.

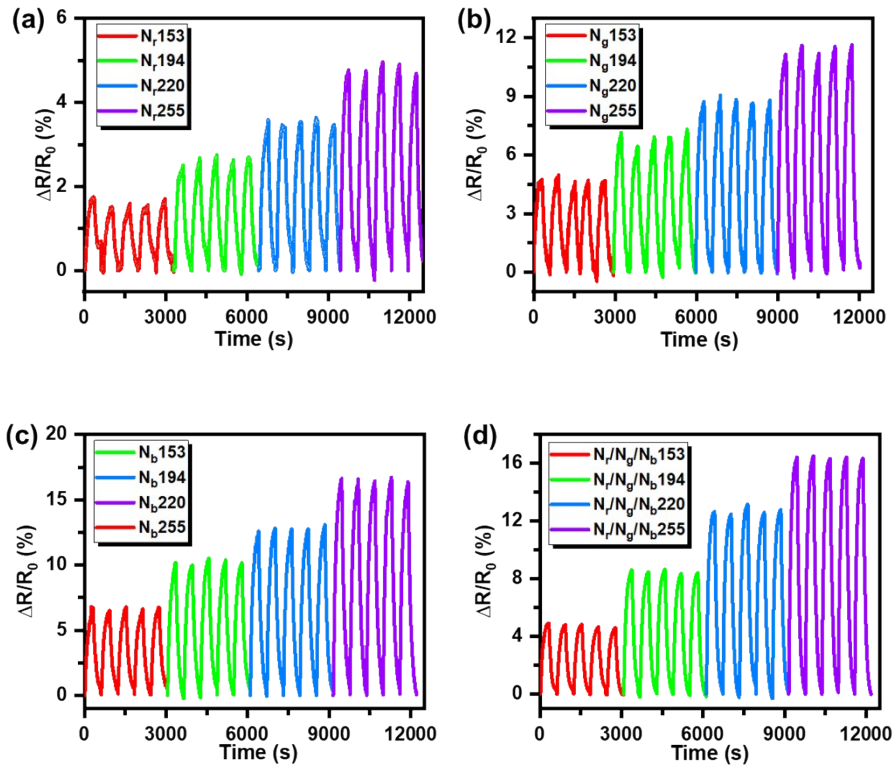

Figure S7. (a) Cycles of Au NR chip irradiated by the red light of different R value (N_r). (b) Cycels of Au NS chip irradiated by the green light of different G value (N_g). (c) Cycles of Ag NS chip irradiated by the blue light of different B value (N_b). (d) Cycles of C NP chip irradiated by the white light of different R/G/B value (N_r/N_g/N_b).

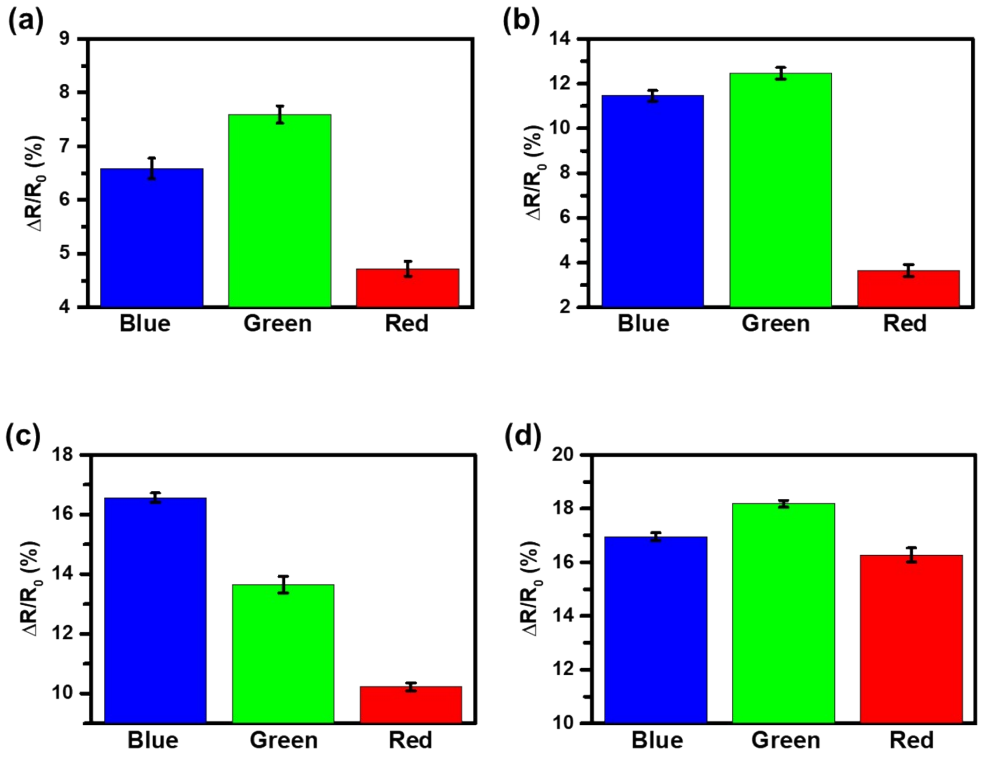

Figure S8. Resistance responses of Au NR (a), Au NS (b), Ag NS (c) and C NP (d) chips irradiated by red (Nr=255), green (Ng=255) or blue (Nb=255) light.

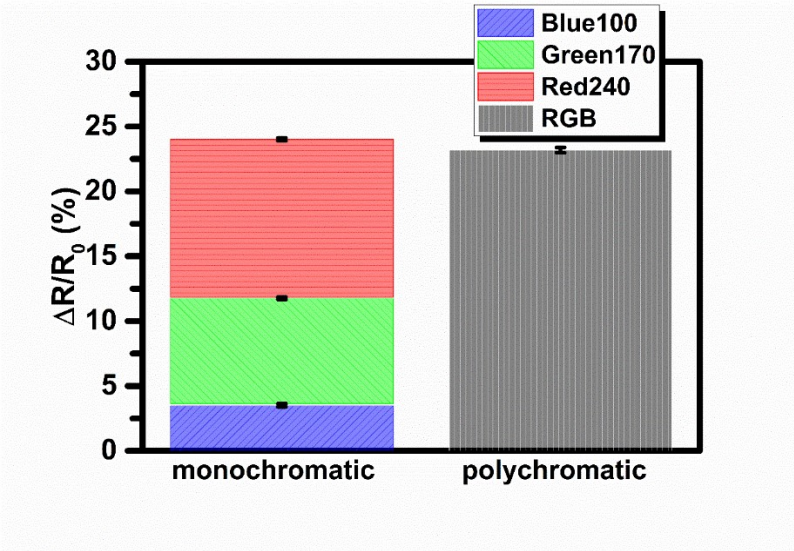

Figure S9. Resistance response of C NP chips irradiated by red (Nr=240), green (Ng=170), blue (Nb=100) light and polychromic light (Nr=240, Ng=170, Nb=100).

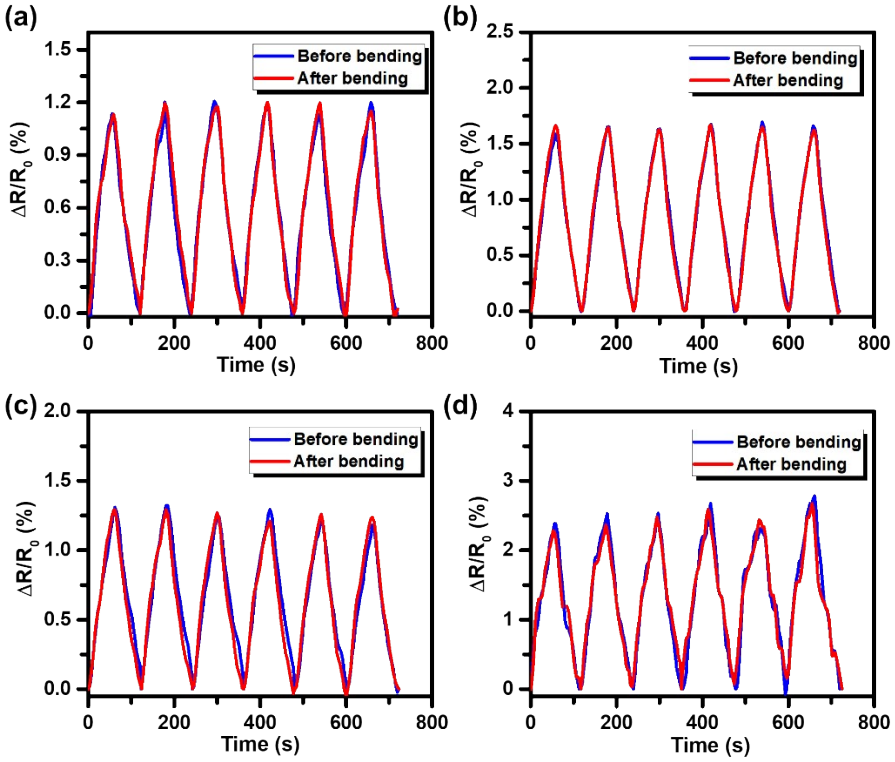

Figure S10. Electrical response circles of Au NR (a), Au NS (b), Ag NS (c) and C NP (d) sub-pixels before and after repeatable bending under the irradiation of white light.

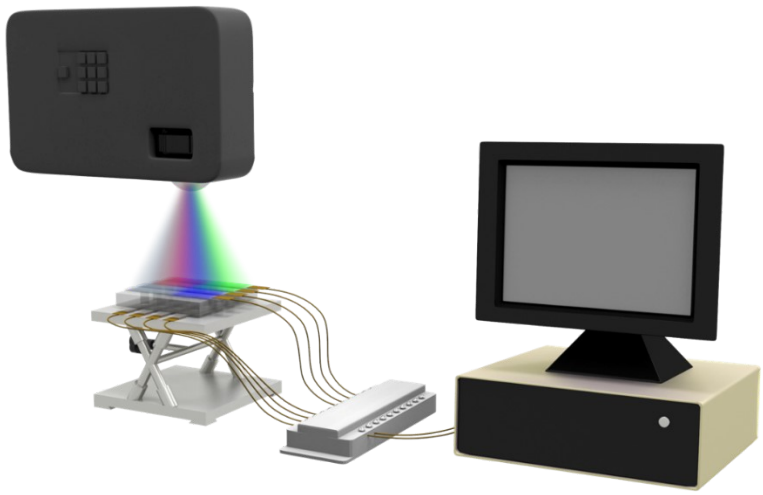

Figure S11. Schematic diagram of the experimental setup of the photosensitive array.