Electronic Supplementary Information

Infrared Response of Self-heating VO_2 Nanoparticles Film based on Ag Nanowires Heater

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I. Experimental Details

a. Synthesis Methods

VO_2 (M) nanoparticles were synthesized by using a hydrothermal and subsequent mild thermal treatment method.[1] Briefly, the starting materials are the mixture of vanadium pentoxide and oxalic acid dehydrate (with molar ratio about 1:1~2), and the surfacant mainly includes polyvinylalcohol and propylene glycol methyl ether acetate (1~2 wt%, respectively). The synthesis was performed in a 50 L autoclave at 220 °C for 36 hrs. After cooling down to room temperature, the resulting nanoparticles were collected by centrifugation, washed alternately with copious amounts of deionized water and ethanol to remove any organic residue, and then dried in air at 70 °C. To obtain VO_2 (M), the as-prepared nanoparticles were annealed in vacuum environment (~20 Pa) at 400 °C for 1 hr. After mixing with PVP in alcohol (5 wt% PVP), VO_2 nanoparticles film were prepared on substrate by spin-coating.

Long Ag nanowires (AgNWs) were synthesized by one step route through a polyol reduction method, and the AgNWs electrode was formed by doctor-blading after dispersing in isopropanol and ethanol solution.[2] Briefly, glass (or flexible poly(ethylene terephthalate), PET) substrates were first cleaned by sequential ultrasonication in acetone, ethanol, and deionized water, and further submitted to O_2 plasma treatment. Dispersion of AgNWs was immediately doctor-bladed on the substrate to form a thin film. The AgNW film/glass electrode was heated in air at 150-200 °C for 20 min and cooled naturally. A 40 MPa pressure was applied on AgNW film for AgNW film/PET electrode. Finally, a thin layer of polyvinyl alcohol (PVA) was coated on the AgNW film. The AgNWs electrode was finished by forming two-terminal side-contacts with copper wires by Ag paste.

b. Characterizations

The morphologies of the as-prepared samples were examined by SEM (Sirion 200). Optical transmission, absorbance and reflectance spectrum were obtained by using a UV-3600 spectrophotometer (Shimadzu ISR-260) at room temperature with an incident optical point of about 14×10 mm^2 equipped with a MPC-3100 integrating sphere assembly. The Voltage was applied by a programmable power supply (IT6860A).

II. Supplementary figures

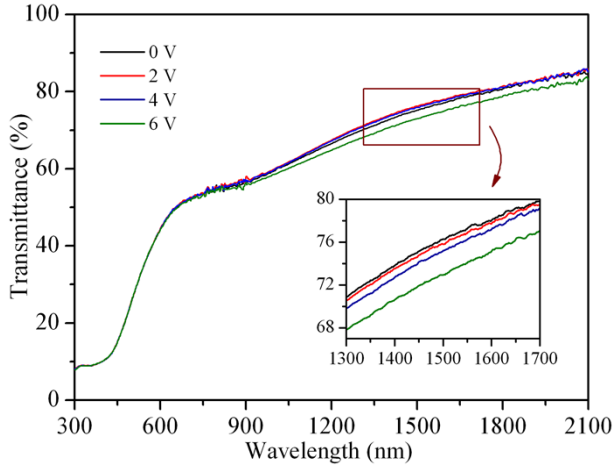

Fig. S1 Transmittance spectra of the electrothermochromic device on glass at input voltage of 0~6 V, the inset shows the enlarge part of the marked area. This result indicates that a visible change in transmittance occurs upon applying even a very low input voltage.

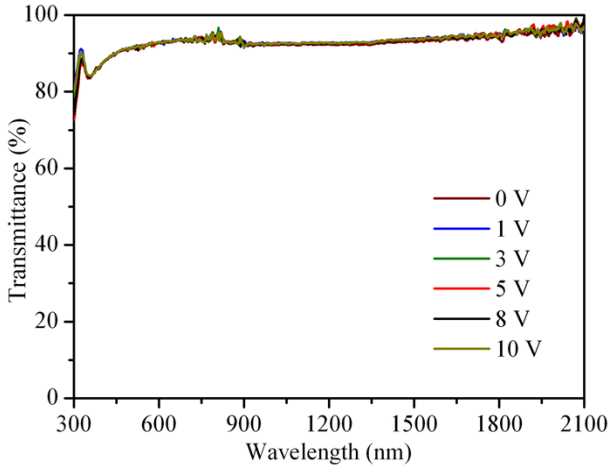

Fig. S2 Transmittance spectra of AgNWs electrode on glass substrate at different input voltages. No obvious transmittance change in visible and infrared ranges can be observed, indicating the infrared modulation in the device comes from VO_2 (M) nanoparticles.

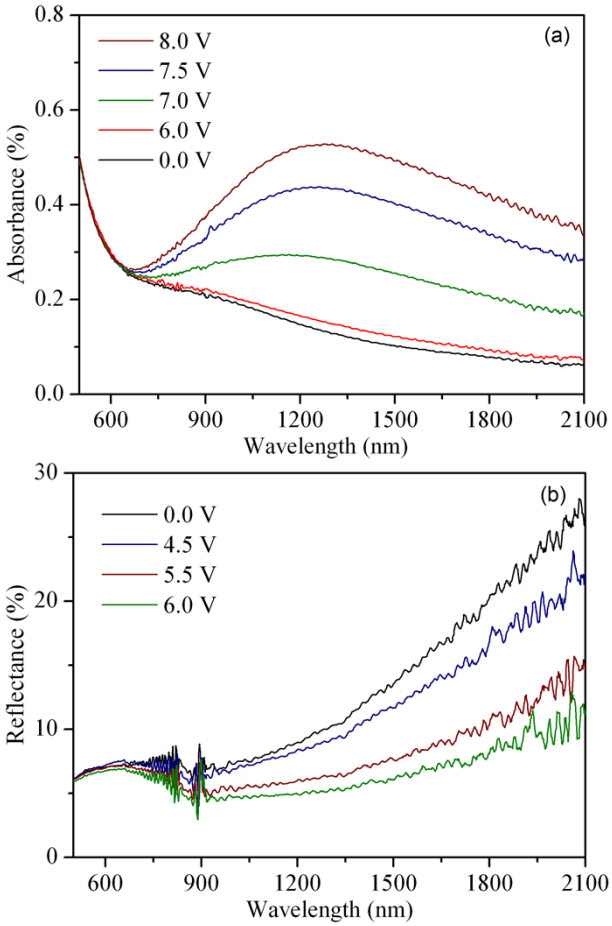

Fig. S3 (a) Absorbance and (b) reflectance spectra of the electrothermochromic device on glass substrate at different input voltages. One can see that the absorbance increases while reflectance decreases with increasing input voltage.

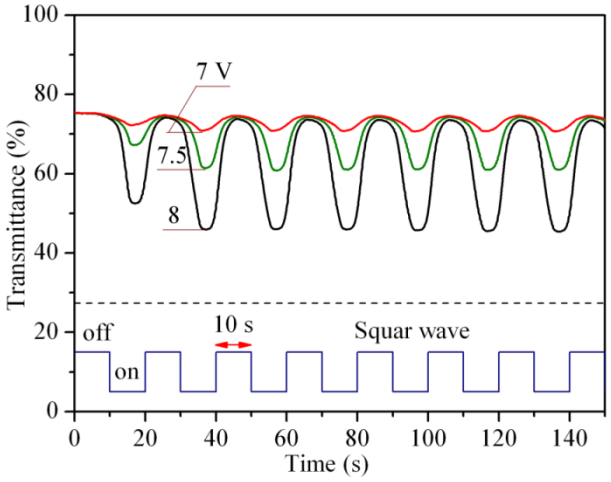

Fig. S4 Infrared response of the device on glass substrate at 1.5 μm upon input voltage with pulse time of 10 s. The dash line denotes the lowest transmittance at a constant voltage of 8 V.

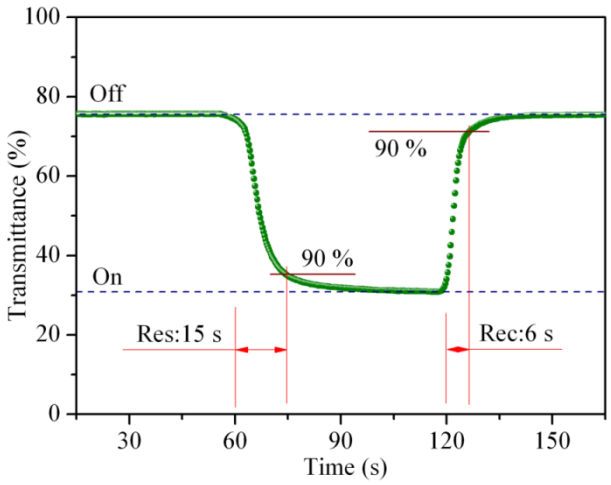

Fig. S5 Infrared response of the device on glass substrate at 1.5 μm upon an 8 V input voltage with 1min pulse time.

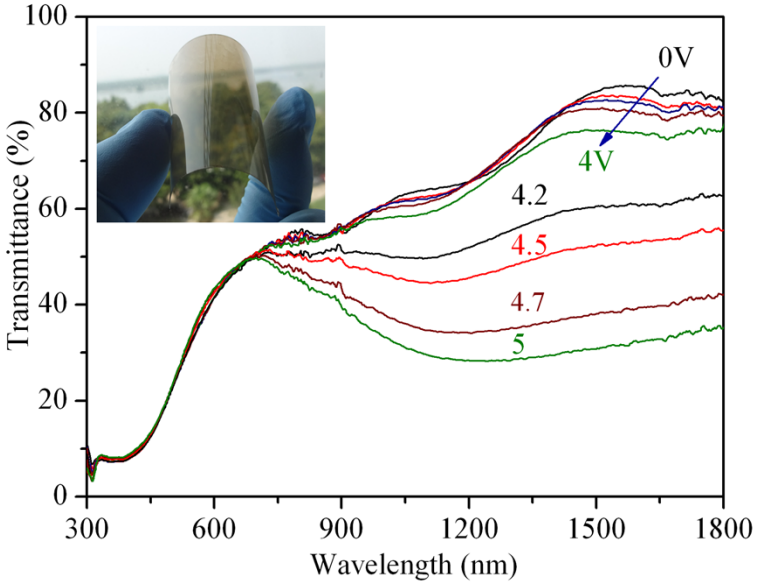

Fig. S6 Transmission spectra of the electrothermochromic device on PET substrate at different input voltage. The inset is a digital photograph showing the flexibility of the device.

(1) Li, M.; Wu, X.; Li, L.; Wang, Y.; Li, D.; Pan, J.; Li, S.; Sun, L.; Li, G., Defect-mediated phase transition temperature of VO_2 (M) nanoparticles with excellent thermochromic performance and low threshold voltage. *J. Mater. Chem. A,* **2014,** *2*, 4520-4523.

(2) Ji, S.; He, W.; Wang, K.; Ran, Y.; Ye, C., Thermal Response of Transparent Silver Nanowire/PEDOT:PSS Film Heaters. *Small* **2014**, DOI: 10.1002/smll.201401690.