Enhanced photoelectrochemical response in $SrTiO_3$ films decorated with carbon quantum dots

Supplementary Information

Experimental details

Synthesis of CQDs. CQDs were synthesized through an alkali-assisted electro-chemical method. In a typical experiment, the electrolyte of the electrochemical process was prepared by mixing ethanol/H_2O (100 mL; volume ratio = 99.5:0.5) with a suitable amount (0.3–0.4 g) of NaOH. By using graphite rods (diameter about 0.5 cm) as both anode and cathode, we synthesized CQDs with a current intensity in the range of 10–200 mA cm^{-2}. CQDs were separated by column chromatography. Firstly, the raw CQDs solution was treated by adding a suitable amount of $MgSO_4$ (5–7 wt%), stirred for 20 min, and then stored for 24 h to remove the salts and water. Afterwards, the purified CQDs solution was separated by silica-gel column chromatog-raphy with a mixture of petroleum ether and diethyl ether as the developing solvent.

Synthesis of TiO_2 NTs. Titanium foil (0.1 mm, 99.6% purity) was cut into 1 cm × 1.5 cm strips. These strips were, respectively, degreased by acetone, ethanol and deionized water with ultrasonication for each 10 min, and then dried in air. The self-organized TiO_2 NTs were fabricated by anodization of titanium foils in a mixed electrolyte of ethylene glycol and water (100:1 vol. %) + 1 wt. % NH_4F. Anodization was performed for 60 min at room temperature (20℃) in a two-electrode configuration, which connected to a 60 V DC power supply with titanium foil as the working electrode, and graphite rod as the counter electrode. After the reaction, the strip was removed from the cell and washed with deionized water. A sonication was performed to remove any surface deposits.

Synthesis of $SrTiO_3$ films. We used the hydrothermal method to form $SrTiO_3$ films using the obtained TiO_2 NTs as precursor. The hydrothermal method was performed as follows: 0.05 M $Sr(OH)_2$ solution was prepared with deionized water in Teflon-lined stainless steel autoclave. Then, the prepared TiO_2 sample was immersed in $Sr(OH)_2$ solution. The hydrothermal vessel was heat-treated at 180 ^{0}C for 24 h. Finally, the resulting sample was removed from the hydrothermal vessel, followed by rinsing and drying.

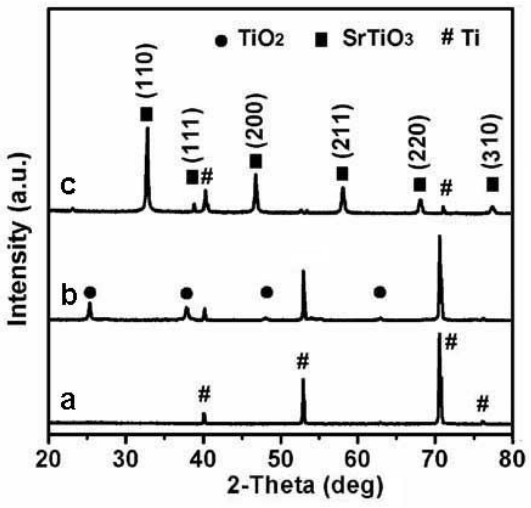

Fig. S1 XRD patterns of (a) Ti peaks originated from Ti metal substrate. (b) TiO_2 NTs array after annealing and (c) $SrTiO_3$ films obtained after hydrothermal treatment of the TiO_2 NTs.

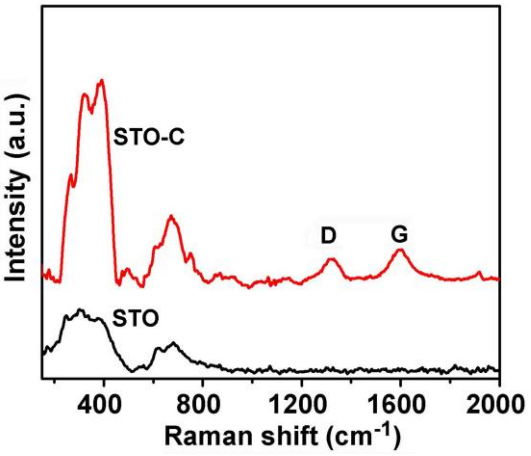

Fig. S2 Raman spectra of STO and STO-C.

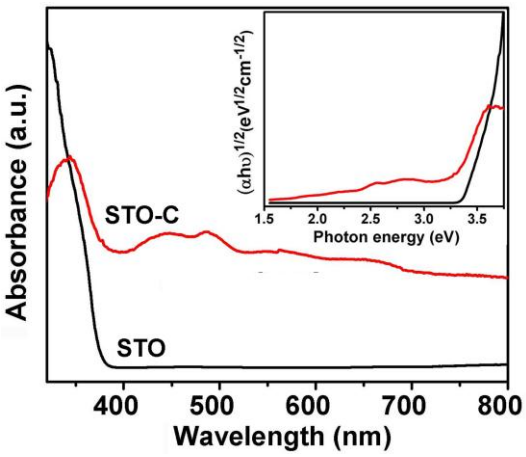

Fig. S3 UV-vis diffuse reflectance spectra of the as-prepared photocatalysts STO and STO-C. Inset shows the corresponding Kubelka–Munk transformed reflectance spectra.

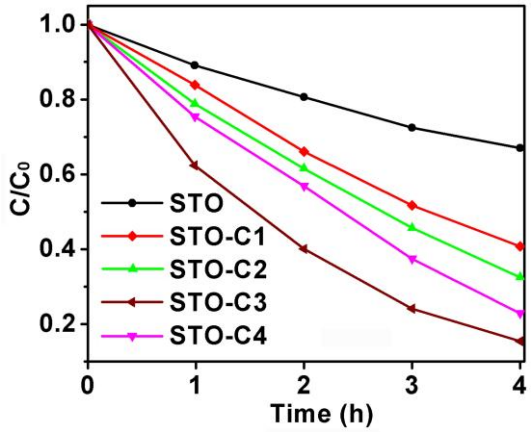

Fig. S4 Photodegradation of methyl orange under simulated sun-light irradiation for the STO-C films corresponding to Fig. 2.