Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Uniform carbon dots@TiO_2 nanotube arrays with full spectrum wavelength light activation for efficient dye degradation and overall water splitting

Qun Wang,[a,b] Jianying Huang,[b] Hongtao Sun,[a] Ke-Qin Zhang,[b] and Yuekun Lai*[b]

[a]College of Chemistry, Chemical Engineering and Materials Science, Soochow University, Suzhou 215123, PR China

[b]National Engineering Laboratory for Modern Silk, College of Textile and Clothing Engineering, Soochow University, Suzhou 215123, PR China

Corresponding author email: yklai@suda.edu.cn

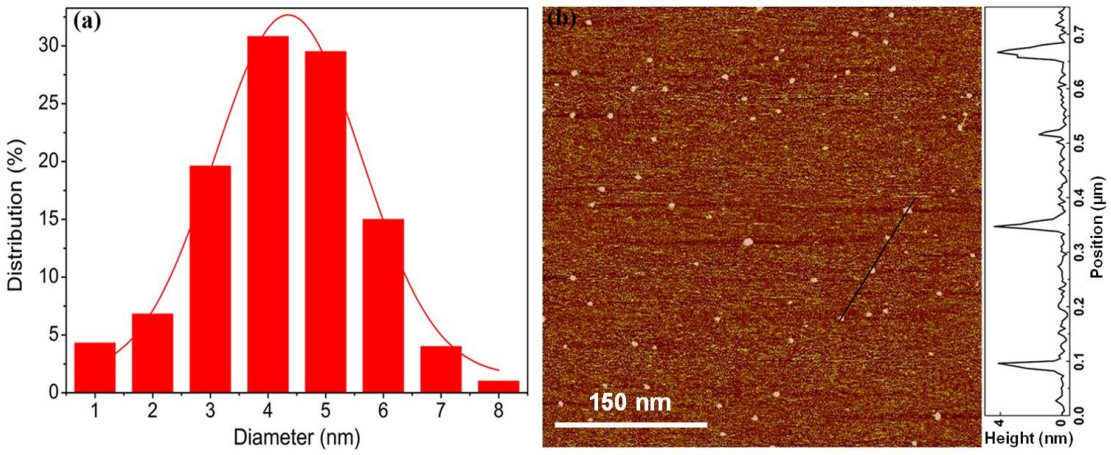

Figure S1. (a) DLS histogram of CDs. (b) A representative AFM topography image of CDs on mica (with a height profile plot along the line).

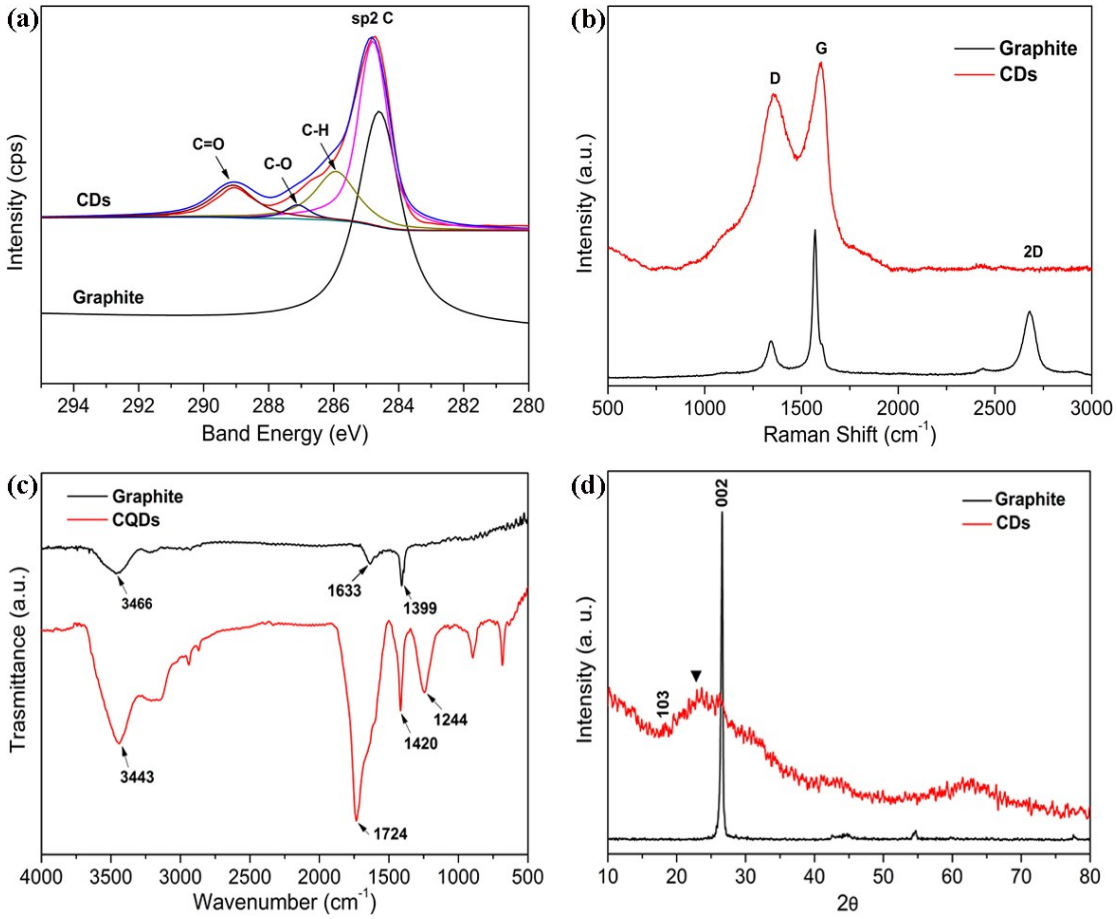

Figure S2. (a) C1s XPS spectra of graphite and CDs where the 284.8 eV peak is assigned to C-C is double bonds. (b) Raman spectra (λ_{ex}=633 nm) of graphite and CDs. Three prominent peaks at 1345, 1570 and 2685 cm^{-1} corresponding to the graphite's D, G and 2D peaks, respectively, and D and G peaks of CDs are located at 1355 and 1600 cm^{-1}. (c) FTIR spectra of graphite and CDs. For graphite, three absorption peaks corresponding to the stretching of the hydroxyl group (3466 cm^{-1}), C=C skeletal vibrations bands (1633 cm^{-1}) and C-O stretching vibrations (1399 cm^{-1}), while for CDs, many strong absorption peaks corresponding to the stretching of the hydroxyl group (3443 cm^{-1}), C=O groups in the carbonyl and carboxyl moieties (1724 cm^{-1}), C=C skeletal vibrations bands (1420 cm^{-1}), C-O stretching vibrations in the epoxy groups (1244 cm^{-1}, 1073 cm^{-1}). (d) XRD patterns of graphite and CDs.

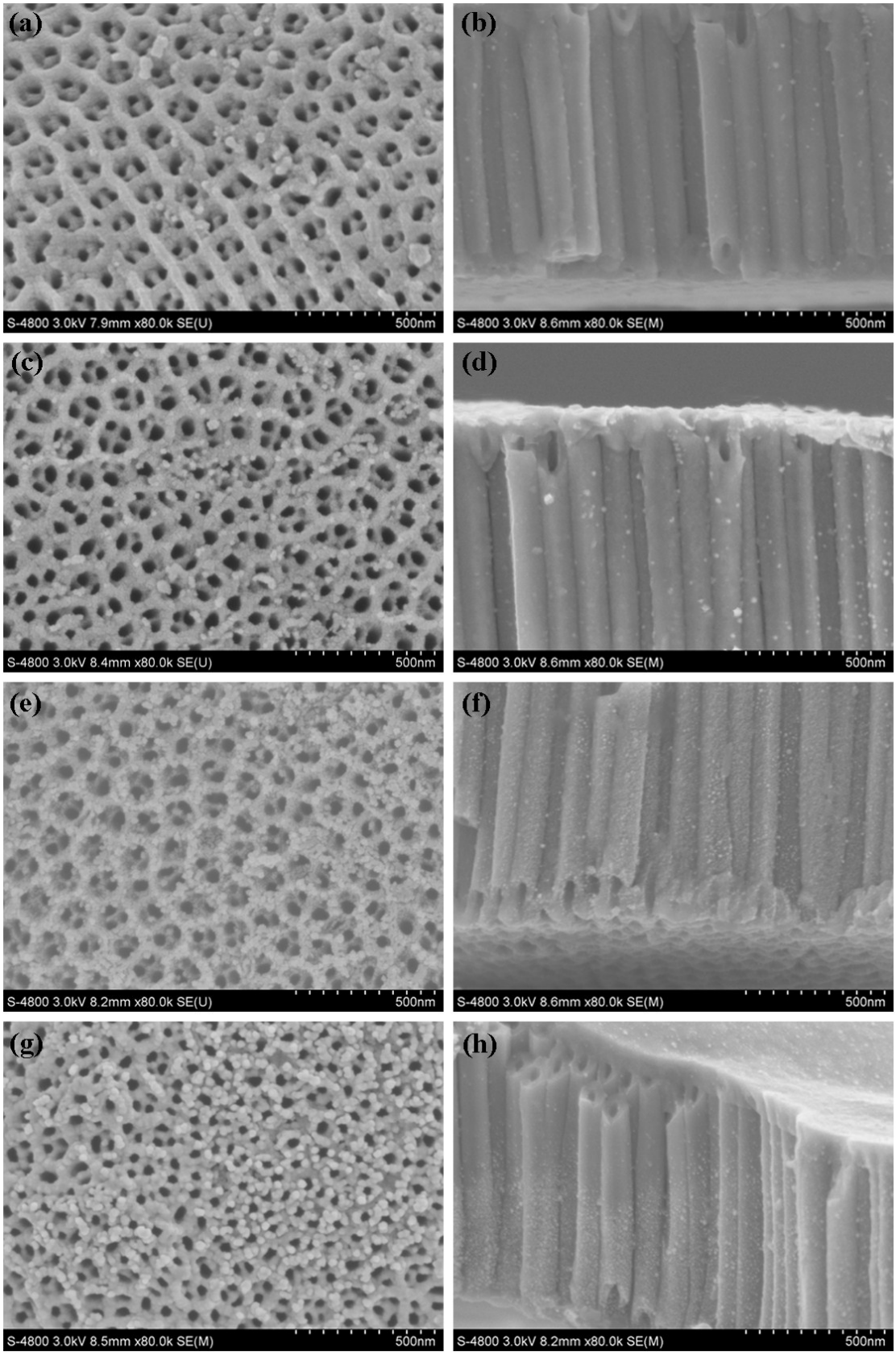

Figure S3. Top-view (a, c, e, g) and side-view (b, d, f, h) SEM images of CDs/TiO_2 NTAs with an electrochemical deposition time of 5, 10, 30 and 40 min, respectively.

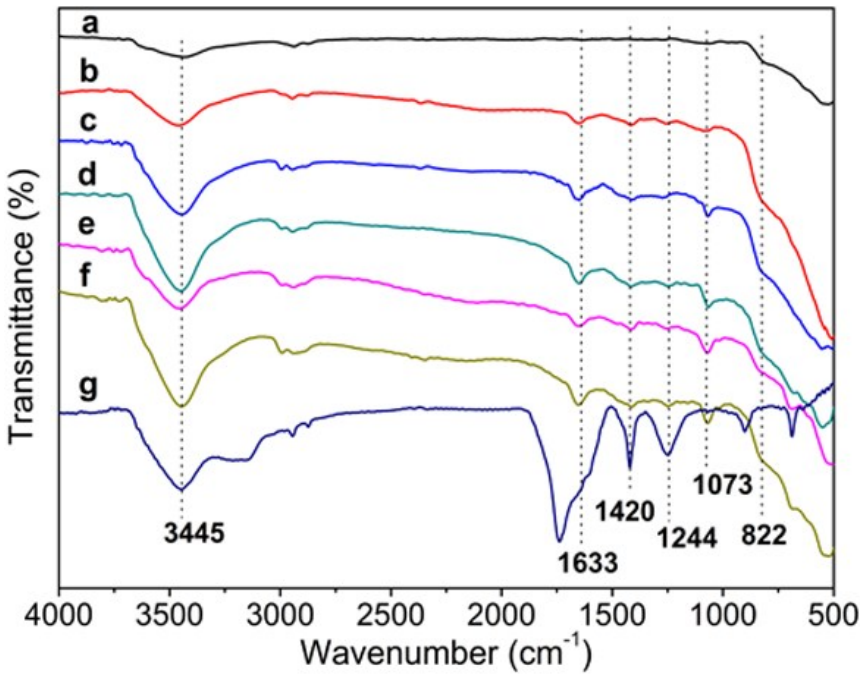

Figure S4. FTIR spectra of TiO_2 NTAs (a), CDs/TiO_2 NTAs with an electrochemical deposition time of 5 (b), 10 (c), 20 (d), 30 (e) and 40 min (f), and CDs (g).

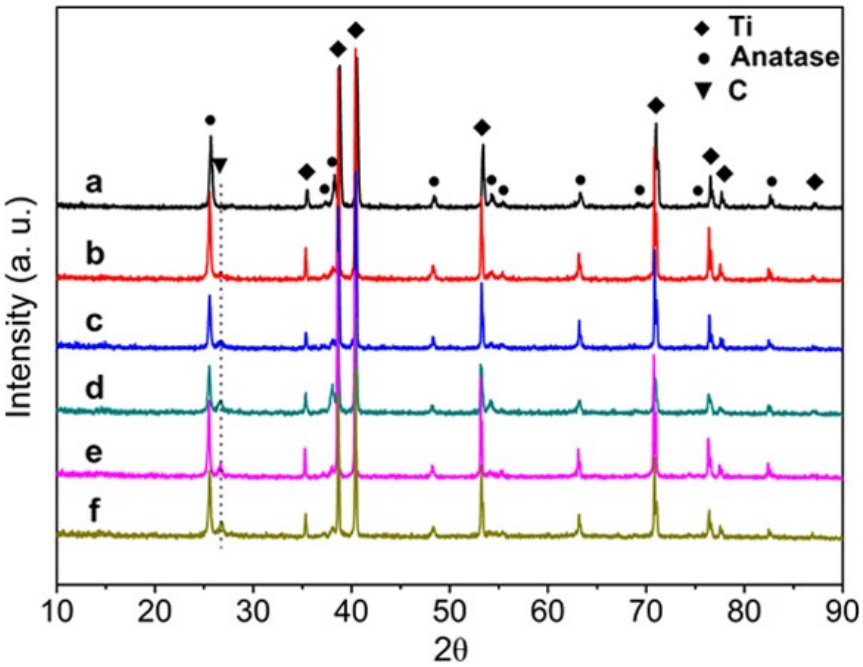

Figure S5. XRD spectra of TiO_2 NTAs (a), CDs/TiO_2 NTAs with an electrochemical deposition time of 5 (b), 10 (c), 20 (d), 30 (e) and 40 min (f).

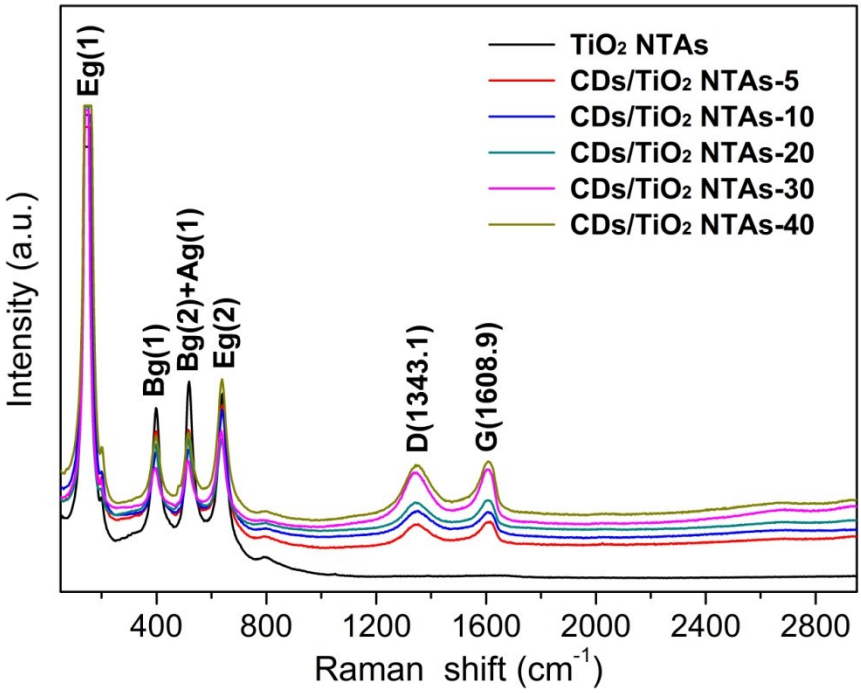

Figure S6. Raman spectra of TiO_2 NTAs and CDs/TiO_2 NTAs with different deposition time of 5, 10, 20, 30 and 40 min.

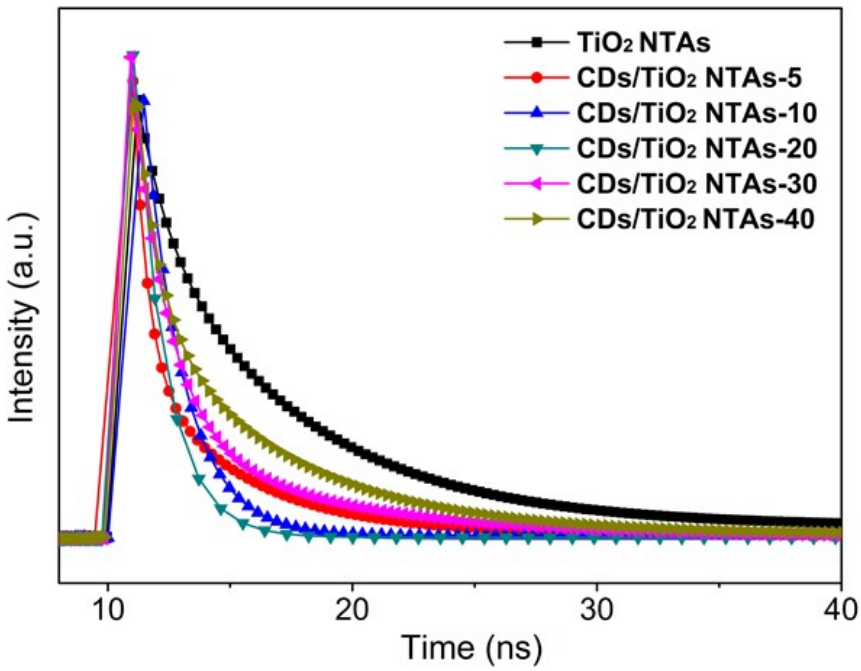

Figure S7. The time-resolved photoluminescence (TRPL) decay profiles for TiO_2 NTAs and CDs/TiO_2 NTAs with different deposition time of 5, 10, 20, 30 and 40 min.

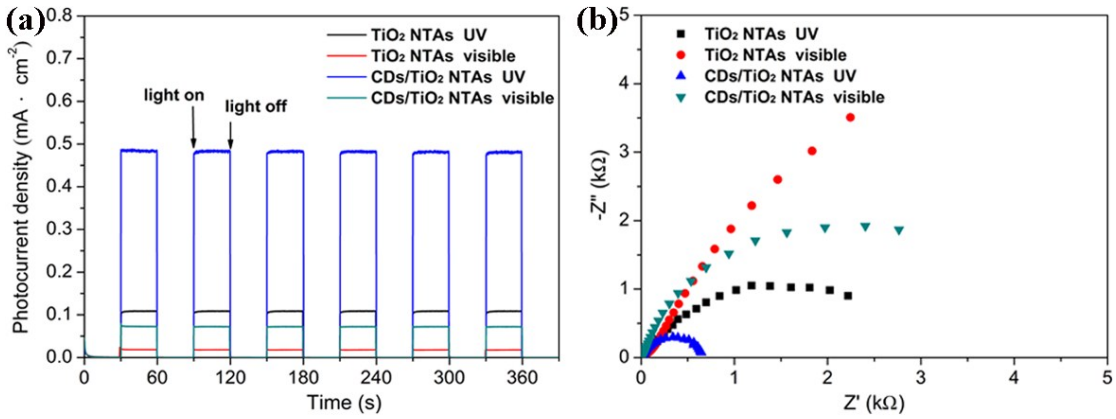

Figure S8. Photocurrent densities versus time curves (a) and EIS Nyquist plots (b) of the pristine TiO_2 NTAs and CDs/TiO_2 NTAs with deposition time of 20 min in 0.1 M Na_2SO_4 solution under UV ($\lambda < 420$ nm) and visible light ($\lambda > 420$ nm) irradiation.

Table S1. Surface compositional analysis of TiO_2 NTAs and CDs/TiO_2 NTAs

Samples	C 1s (Atom%)	O 1s (Atom%)	Ti 2p (Atom%)
TiO_2 NTAs	8.87	59.25	31.88
CDs CDs/TiO_2 NTAs-5	10.52	58.87	30.61
CDs CDs/TiO_2 NTAs-10	13.61	57.36	29.03
CDs CDs/TiO_2 NTAs-20	18.22	53.91	27.87
CDs CDs/TiO_2 NTAs-30	22.36	50.54	27.01
CDs CDs/TiO_2 NTAs-40	25.67	48.26	26.07

Table S2. Kinetic parameters of emission decay analysis of TiO_2 NTAs and CDs/TiO_2 NTAs deduced from double exponential fits

Sample	A_1 (%)	τ_1 (ns)	A_2 (%)	T_2 (ns)	$\tau_{average}$ (ns)
TiO_2 NTAs	12.16	48.87	87.84	33.72	36.25
CDs/TiO_2 NTAs-5	9.46	20.19	90.54	18.23	18.52
CDs/TiO_2 NTAs-10	7.24	29.55	92.76	15.68	17.46
CDs/TiO_2 NTAs-20	5.12	40.27	94.88	11.56	16.10
CDs/TiO_2 NTAs-30	11.36	47.32	88.64	19.53	26.11
CDs/TiO_2 NTAs-40	32.67	44.61	67.33	26.83	34.77

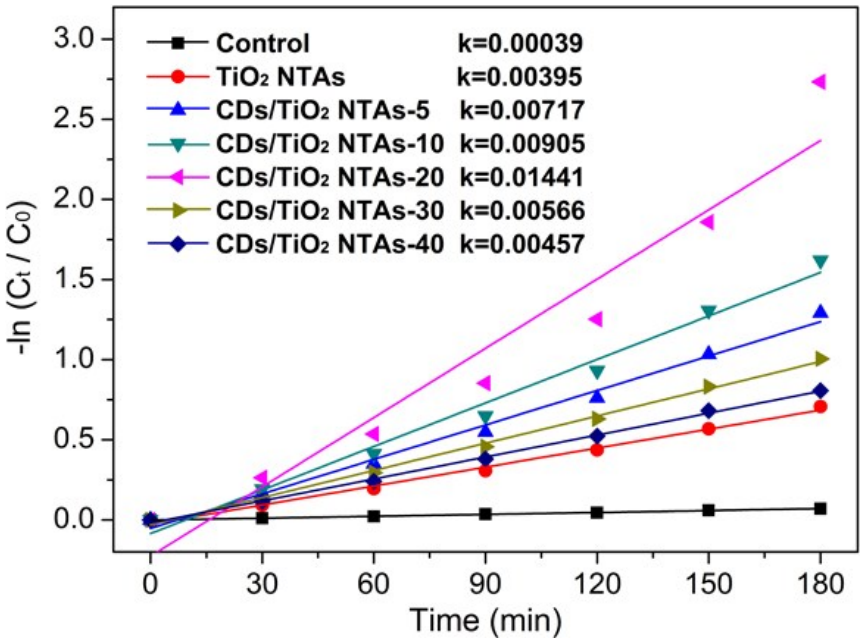

Figure S9. The kinetic rates of photocatalytic degradation curves for RhB using TiO_2 NTAs and CDs/TiO_2 NTAs with different deposition time of 5, 10, 20, 30 and 40 min under the simulated solar light illumination (100 mW·cm^{-2}).

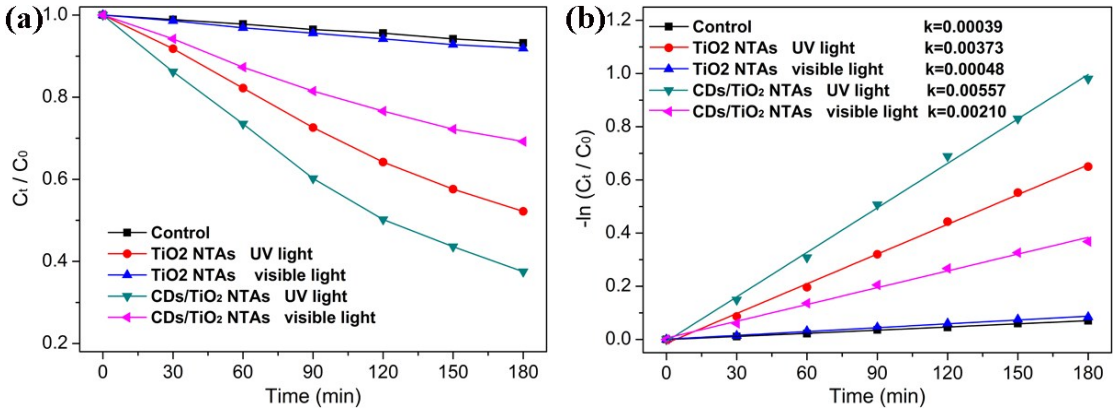

Figure S10. (a) Photocatalytic degradation curves for RhB and (b) corresponding kinetic rates by using TiO_2 NTAs and CDs/TiO_2 NTAs with a deposition time of 20 min as catalysts under different irradiation conditions. The UV and visible light denote $\lambda < 420$ nm and $\lambda > 420$ nm, whose power densities are measured to be 2.7 and 100 mW·cm^{-2}, respectively.

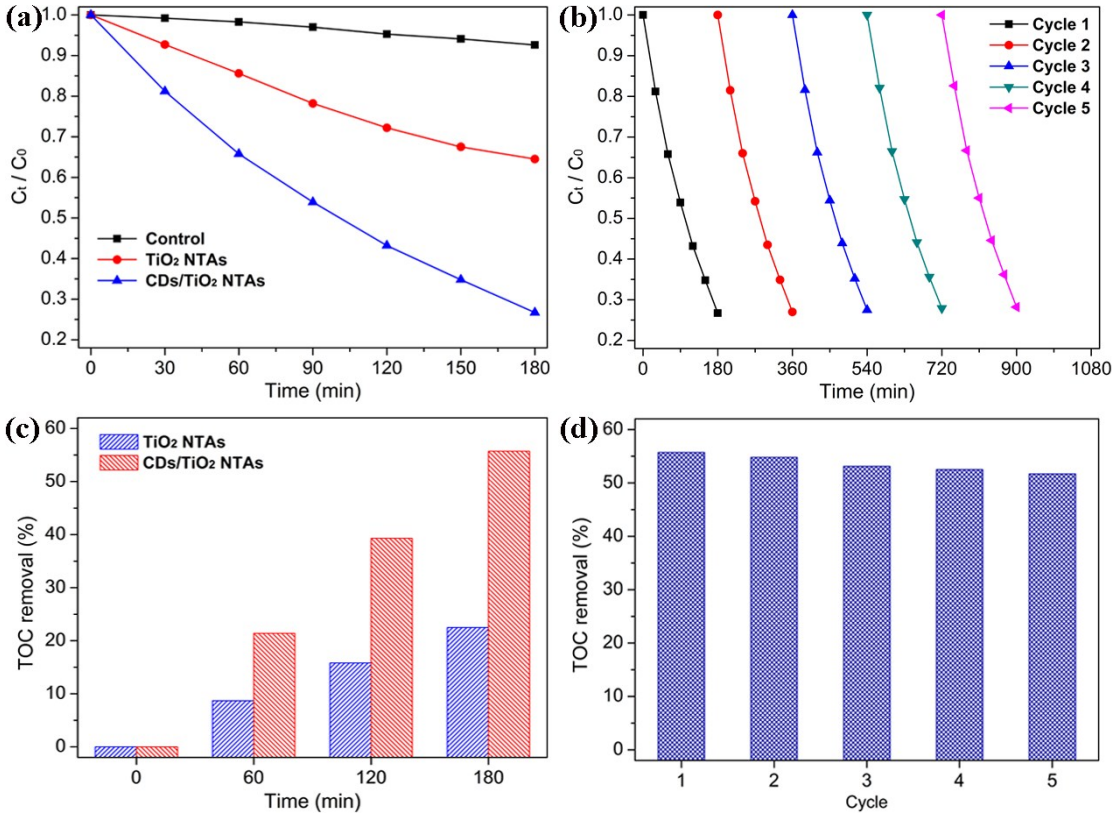

Figure S11. (a) Photocatalytic phenol degradation by self-degradation, using TiO_2 NTAs and CDs/TiO_2 NTAs with deposition time of 20 min, respectively. (b) Consecutive photocatalytic degradation of phenol using one CDs/TiO_2 NTAs with deposition time of 20 min sample 5 continuous cycles. (c) TOC removal efficiency during photocatalytic degradation using TiO_2 NTAs and CDs/TiO_2 NTAs with deposition time of 20 min, respectively. (d) TOC removal efficiencies of photocatalytic phenol degradation by using one sample for CDs/TiO_2 NTAs with a deposition time of 20 min for continuous 5 consecutive cycles under the same condition. C_0, C_t is the initial concentration and concentration after a certain reaction time of phenol, respectively.