Electronic Supplementary Information

Tuning mixed-phase Nb doped titania films for high-performance photocatalyst with enhanced whole-spectrum light absorption

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1. Jade refinement XRD patterns of NTO film 120-A+R，80-G and 100-G

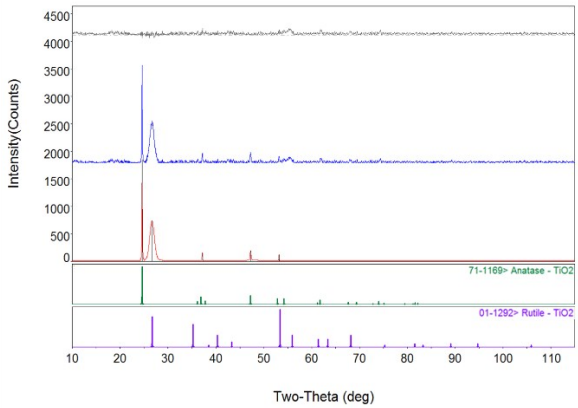

Figure S1-1 Jade refinement profiles: XRD pattern (blue solid line, background curve removed, smooth for 2 times), easy-refined pattern (red solid line), and difference (grey solid line) curve for the sample 120-A+R.

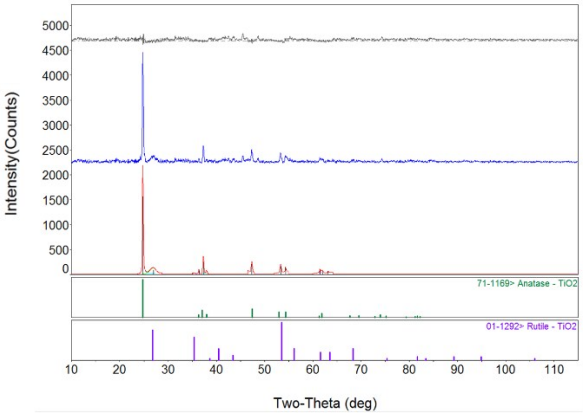

Figure S1-2 Jade refinement profiles: XRD pattern (blue solid line, background curve removed, smooth for 2 times), easy-refined pattern (red solid line), and difference (grey solid line) curve for the sample 80-G.

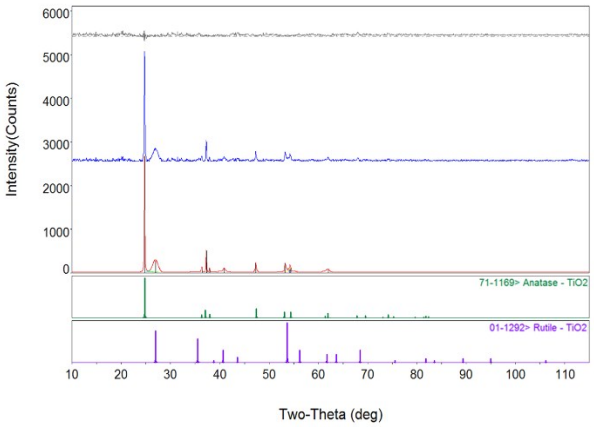

Figure S1 -3 Jade refinement profiles: XRD pattern (blue solid line, background curve removed, smooth for 2 times), easy-refined pattern (red solid line), and difference (grey solid line) curve for the sample 100-G

2. Electrical data of prepared NTO thin films

Table S1. Electrical Resistivity of Prepared NTO Thin Films

Sample name	ρ [Ω cm]
40-SL	1.49×10^{-3}
40-G	1.22×10^{-3}
60-SL	1.40×10^{-3}
60-G	3.30×10^{-3}
80-SL	1.55×10^{-3}
80-G	3.17×10^{-3}
100-SL	9.65×10^{-4}
100-G	9.82×10^{-2}
120-SL	3.66×10^{-3}
120-G	1.62×10^{-1}
140-SL	1.43×10^{-1}
140-G	1.56×10^{-1}
120-A+R	3.61×10^{-1}

3. XRD pattern for NTO nano seed layer substrate

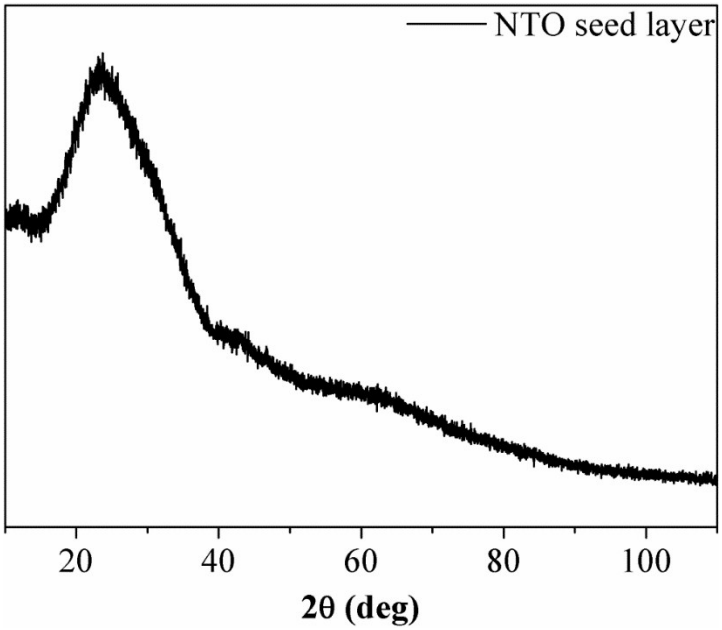

Figure S2. X-ray diffraction pattern of the NTO nano seed layer deposited onto bare soda-lime glass.

4. XRD pattern for mixed phase thin film

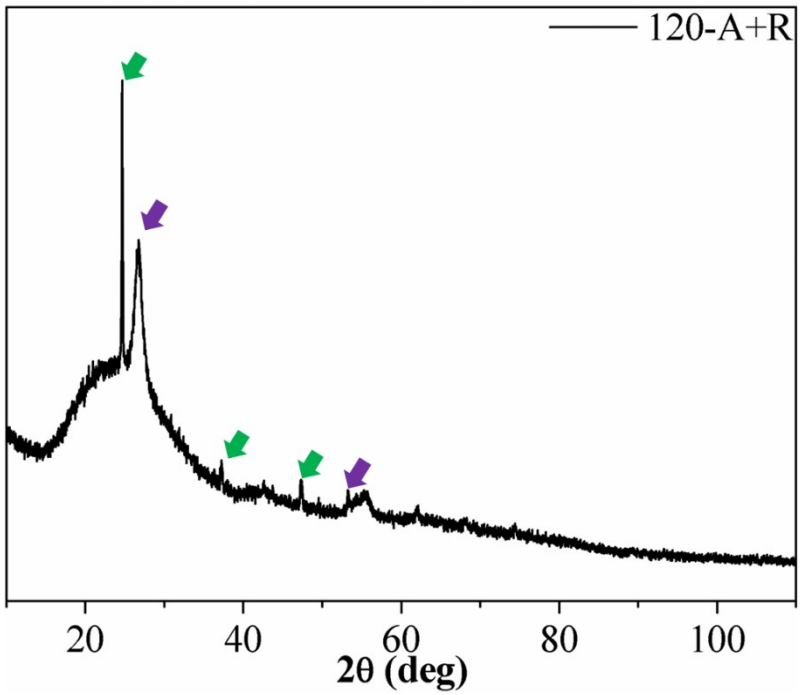

Figure S3-1. X-ray diffraction pattern of the special selected sample 120-A+R. Both anatase (green arrow) and rutile (purple arrow) characteristic peaks could be seen notably.

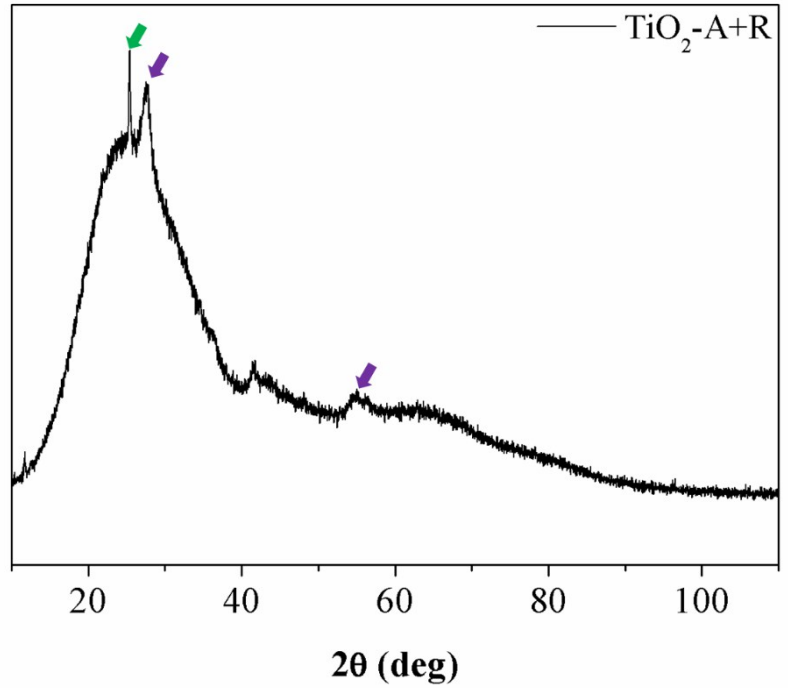

Figure S3-2. X-ray diffraction pattern of the special selected sample TiO_2-A+R. Both anatase (green arrow) and rutile (purple arrow) characteristic peaks could be seen notably.

5. Transmittance spectra for prepared NTO thin films

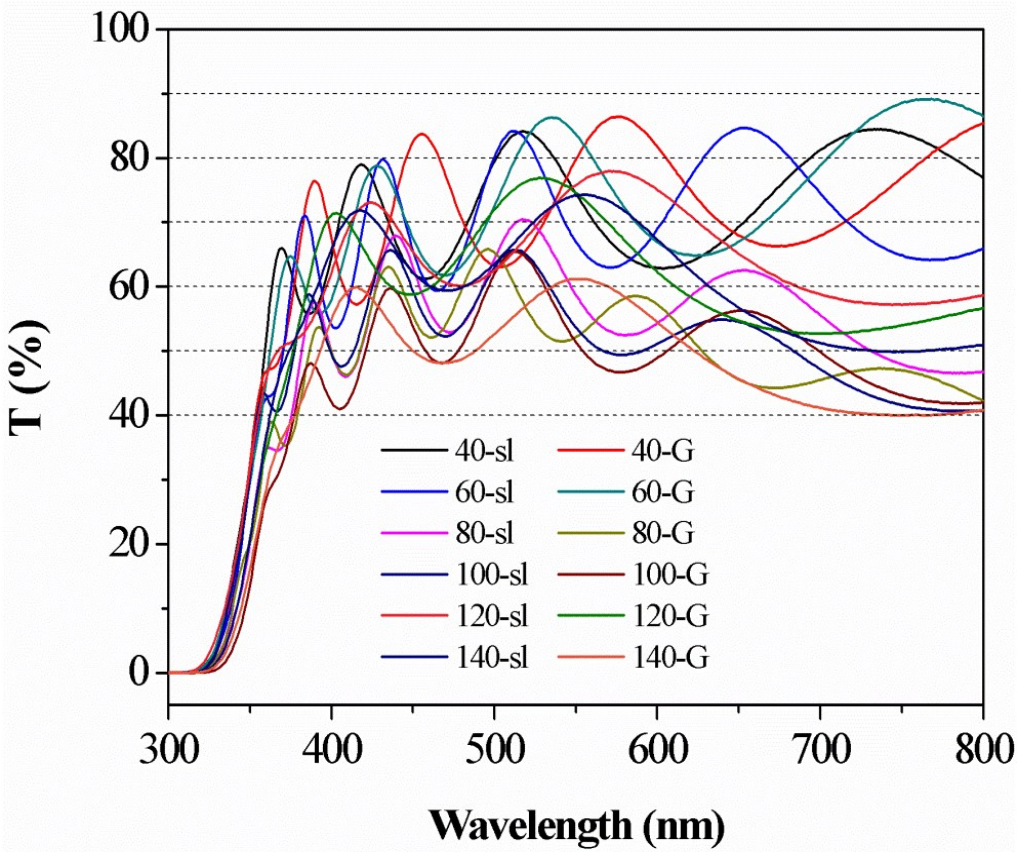

Figure S4. Optical transmittance (T) for anatase NTO thin films.

6. X-ray photoelectron spectroscopy (XPS) spectra

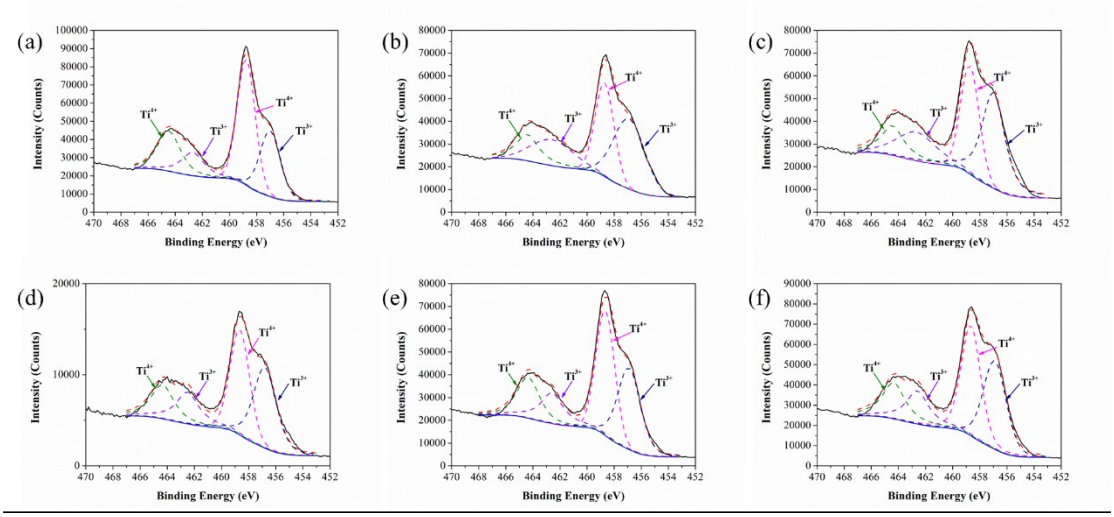

Figure S5. X-ray photoelectron spectroscopy (XPS) spectra of NTO-A (a), NTO-A+R (b), NTO-R (c), TiO_2-A (d), TiO_2-A+R (e) and TiO_2-R (f) thin films showing Ti^{4+} and Ti^{3+} state for the $2p_{3/2}$ transition. The data was treated with a Shirley background and individual Gaussian/Lorentzian functions for Ti^{4+} and Ti^{3+}

7. Additional photocatalytic degradation figures

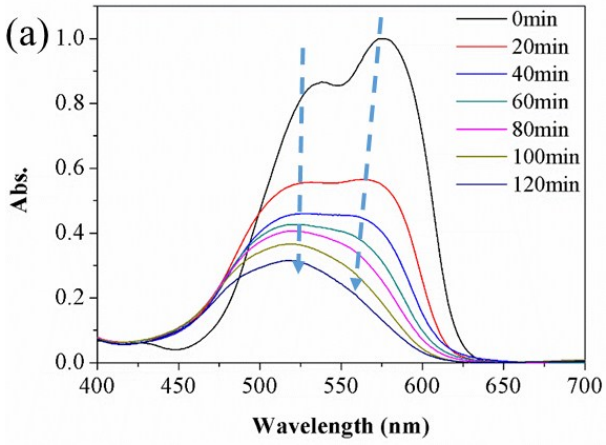

Figure S6. (a) Absorption spectra of a surface-coated Rh B degraded by annealed NTO-A thin films under simulated solar light irradiation.

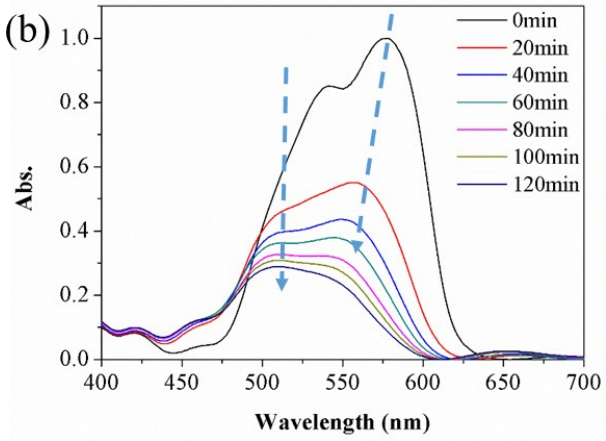

Figure S6. (b) Absorption spectra of a surface-coated Rh B degraded by annealed NTO-A+R thin films under simulated solar light irradiation

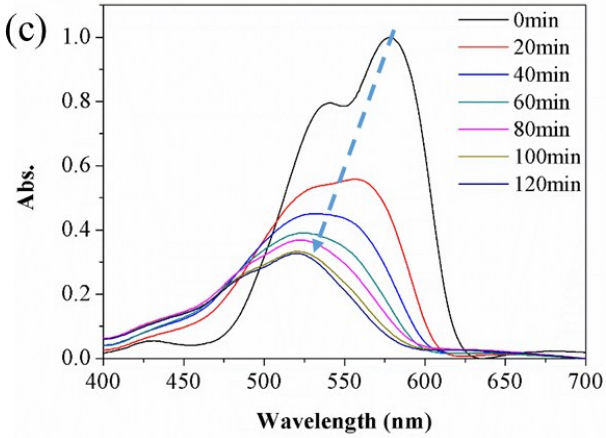

Figure S6. (c) Absorption spectra of a surface-coated Rh B degraded by annealed NTO-R thin films under simulated solar light irradiation

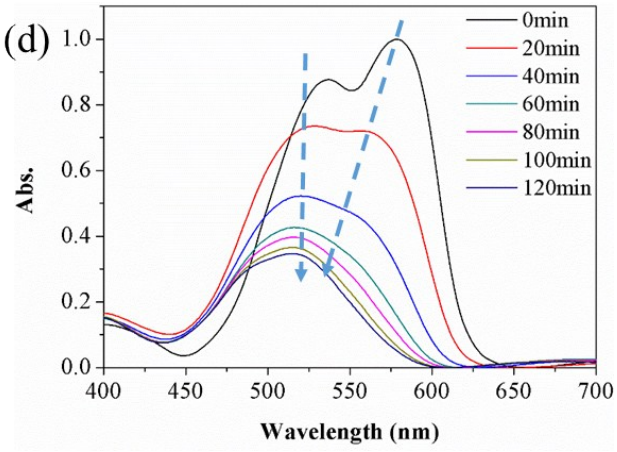

Figure S6. (d) Absorption spectra of a surface-coated Rh B degraded by annealed TiO_2-A thin films under simulated solar light irradiation.

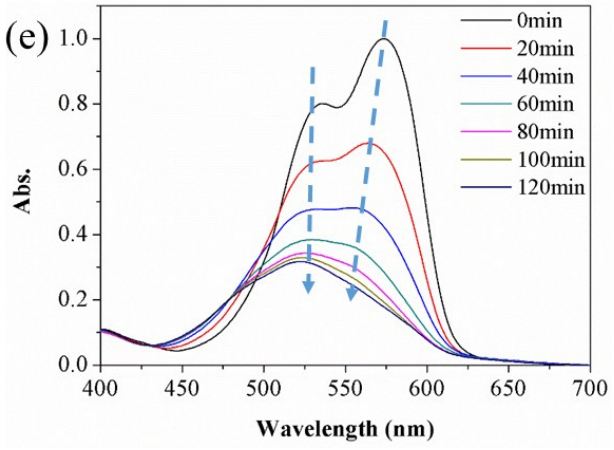

Figure S6. (e) Absorption spectra of a surface-coated Rh B degraded by annealed TiO_2-A+R thin films under simulated solar light irradiation

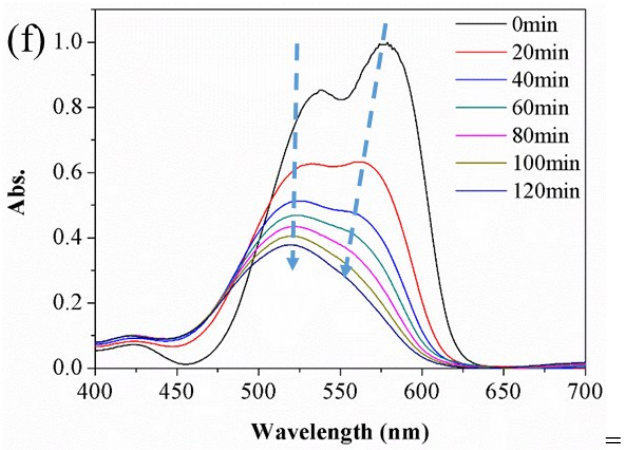

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Figure S6. (f) Absorption spectra of a surface-coated Rh B degraded by annealed TiO_2-R thin films under simulated solar light irradiation

8. SEM&FIB images of samples for TEM observation

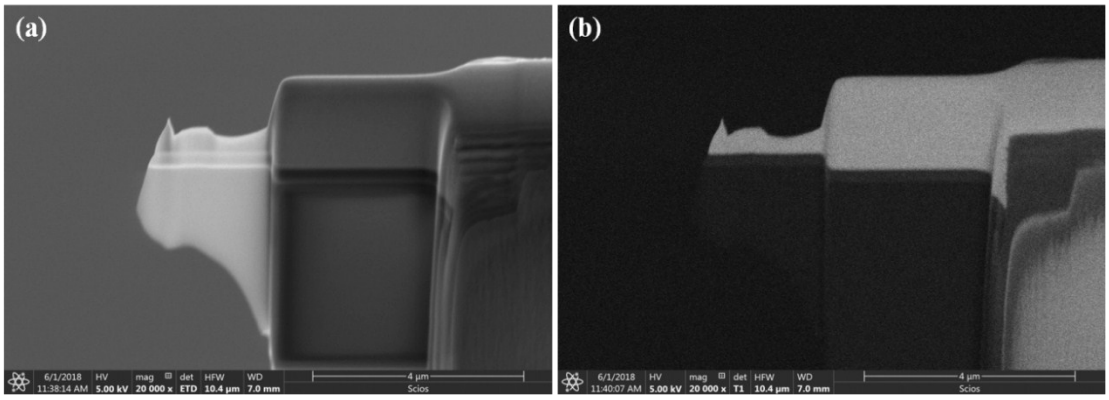

Figure S7-1. (a) SEM image of as-grown 40-G by FIB sampling treatment. (b) Backscattered electron (BSE) image of as-grown 40-G by FIB sampling treatment, the light part shows the surface of film was protected by the Pt layer.

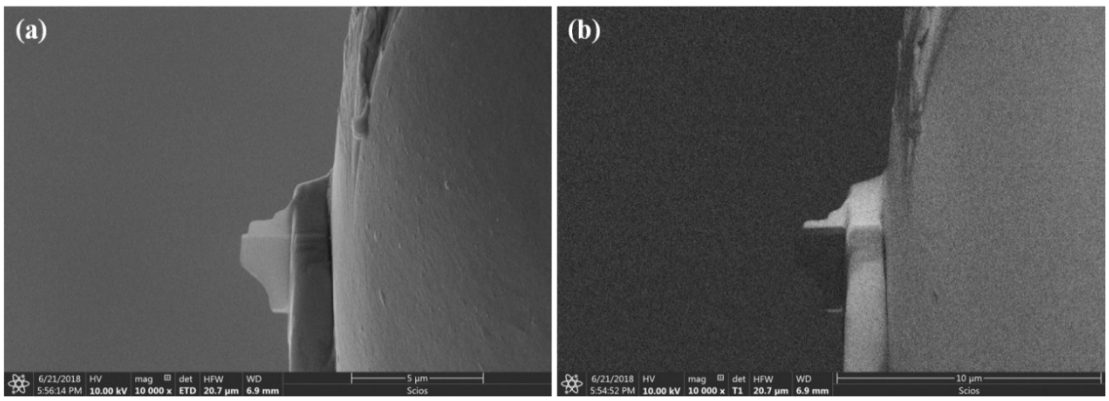

Figure S7-2. (a) SEM image of annealed 40-G by FIB sampling treatment. (b) Backscattered electron (BSE) image of annealed 40-G by FIB sampling treatment, the light part shows the surface of film was protected by the Pt layer.

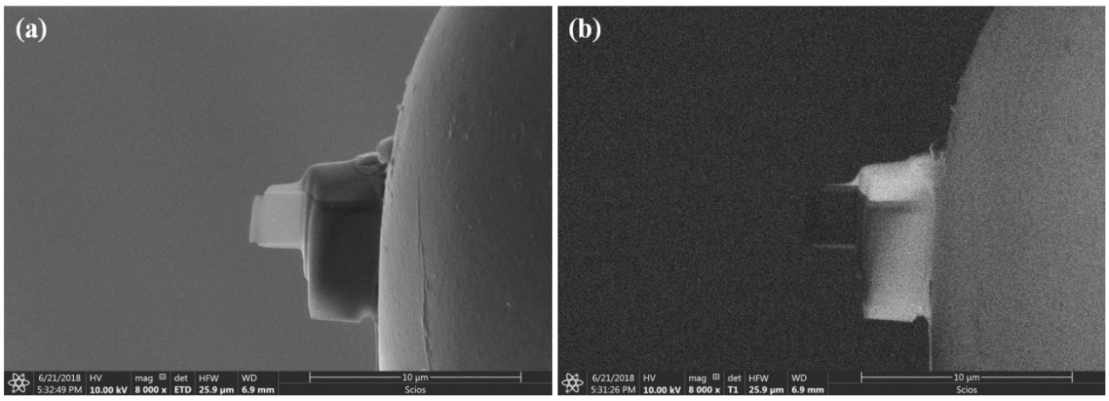

Figure S7-3. (a) SEM image of as-grown 80-G by FIB sampling treatment. (b) Backscattered electron (BSE) image of as-grown 80-sl by FIB sampling treatment, the light part shows the surface of film was protected by the Pt layer.

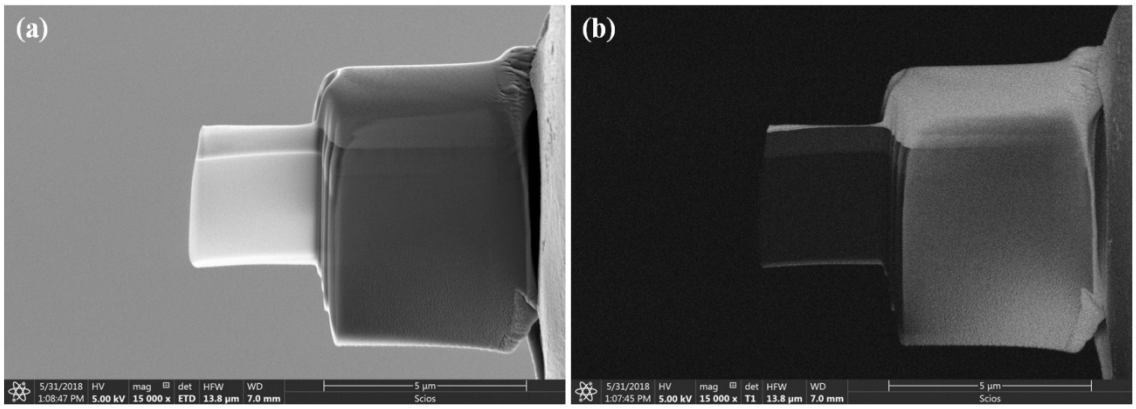

Figure S7-4. (a) SEM image of annealed 80-G by FIB sampling treatment. (b) Backscattered electron (BSE) image of annealed 80-sl by FIB sampling treatment, the light part shows the surface of film was protected by the Pt layer.

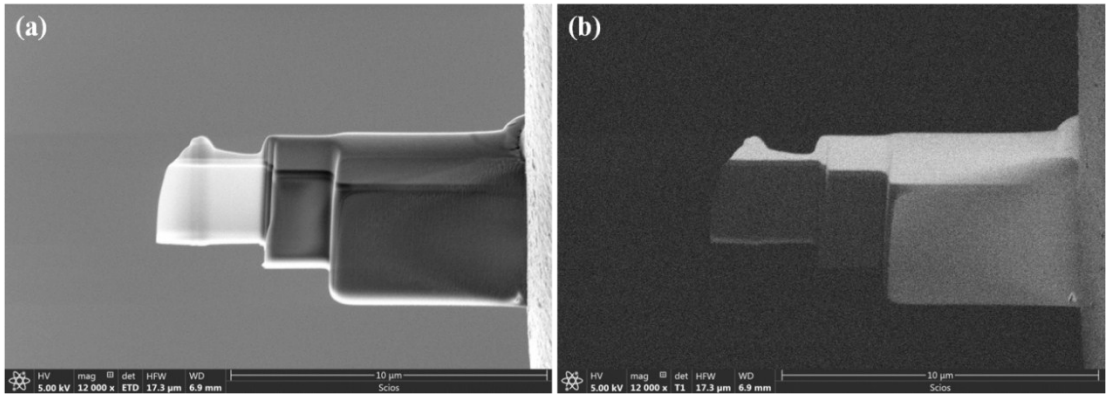

Figure S7-5. (a) SEM image of as-grown 120-G by FIB sampling treatment. (b) Backscattered electron (BSE) image of as-grown 120-G by FIB sampling treatment, the light part shows the surface of film was protected by the Pt layer.

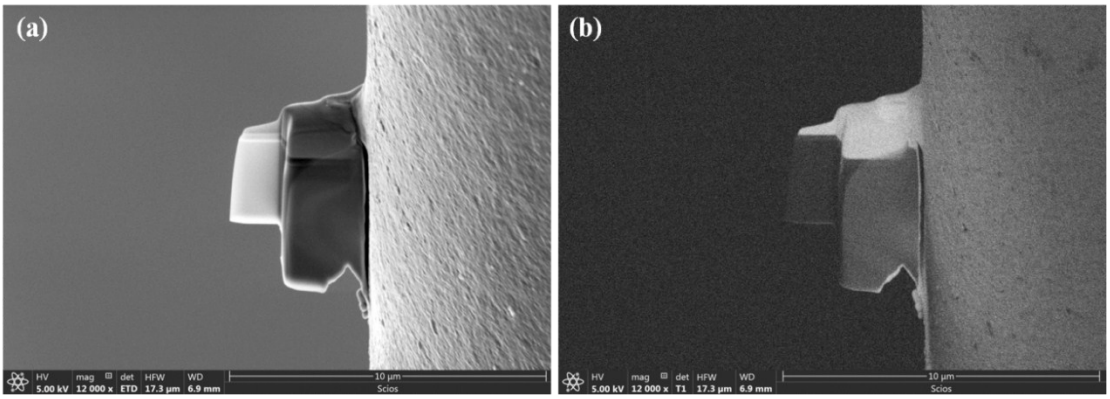

Figure S7-6. (a) SEM image of annealed 120-G by FIB sampling treatment. (b) Backscattered electron (BSE) image of annealed 120-G by FIB sampling treatment, the light part shows the surface of film was protected by the Pt layer.

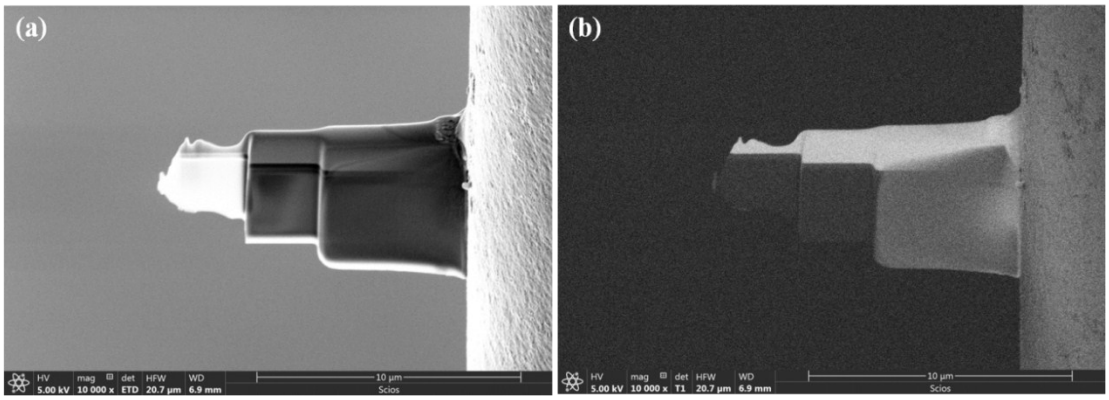

Figure S7-7. (a) SEM image of as-grown 120-SL by FIB sampling treatment. (b) Backscattered electron (BSE) image of as-grown 120-sl by FIB sampling treatment, the light part shows the surface of film was protected by the Pt layer.

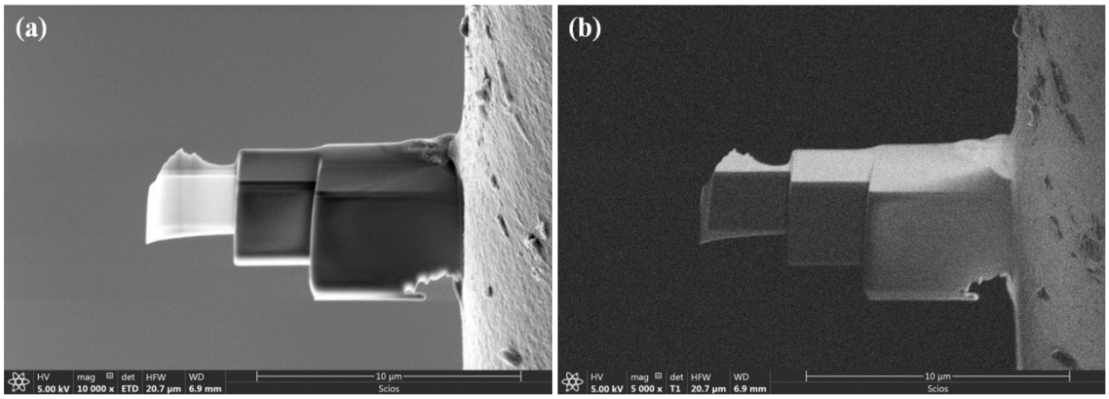

Figure S7-8. (a) SEM image of annealed 120-SL by FIB sampling treatment. (b) Backscattered electron (BSE) image of annealed 120-sl by FIB sampling treatment, the light part shows the surface of film was protected by the Pt layer.

9. EDS images of mixed-phase Nb-doped TiO2 film

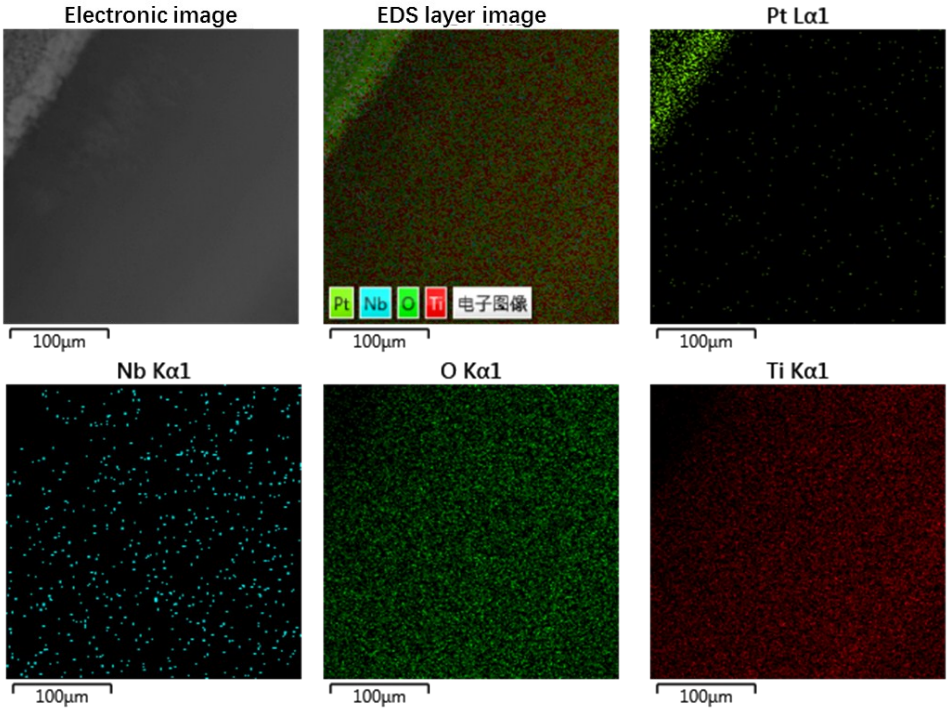

Figure S8-1 EDS images of mixed-phase Nb-doped TiO_2 film

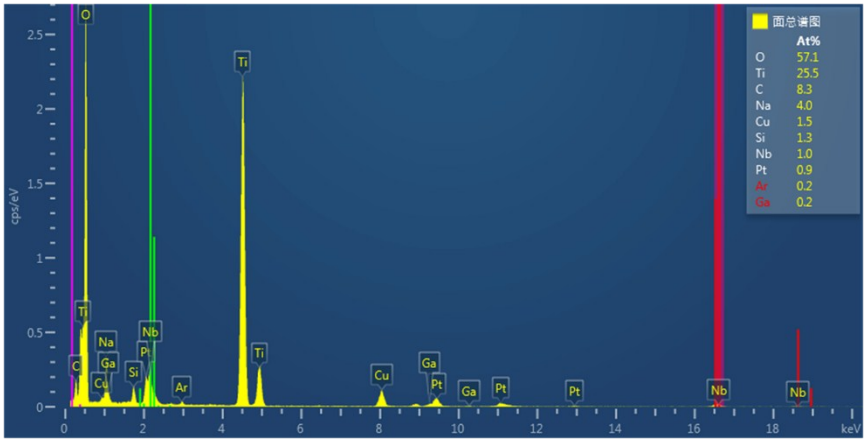

Figure S8-2 EDS result of mixed-phase Nb-doped TiO_2 film (3.9% Nb: 96.1% Ti)

10. Schematic diagram of FCA (Free carrier absorption)

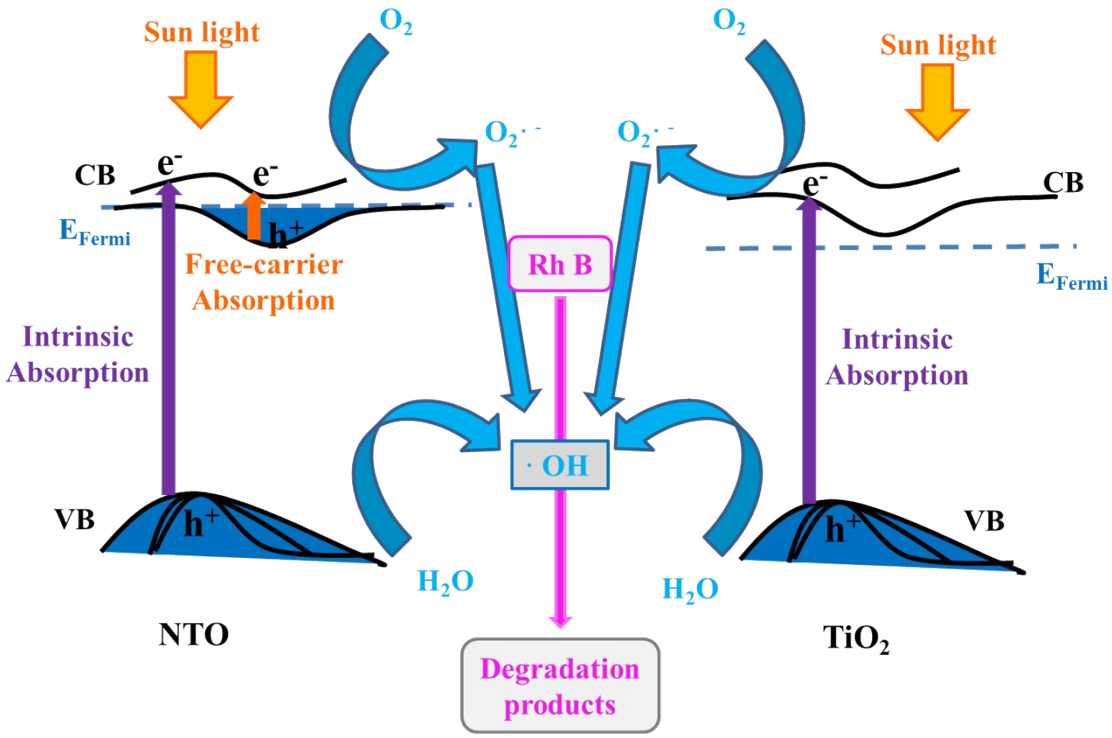

Figure S9 Schematic diagram of FCA (Free carrier absorption)

11. Photos of all six films during long-term irradiation

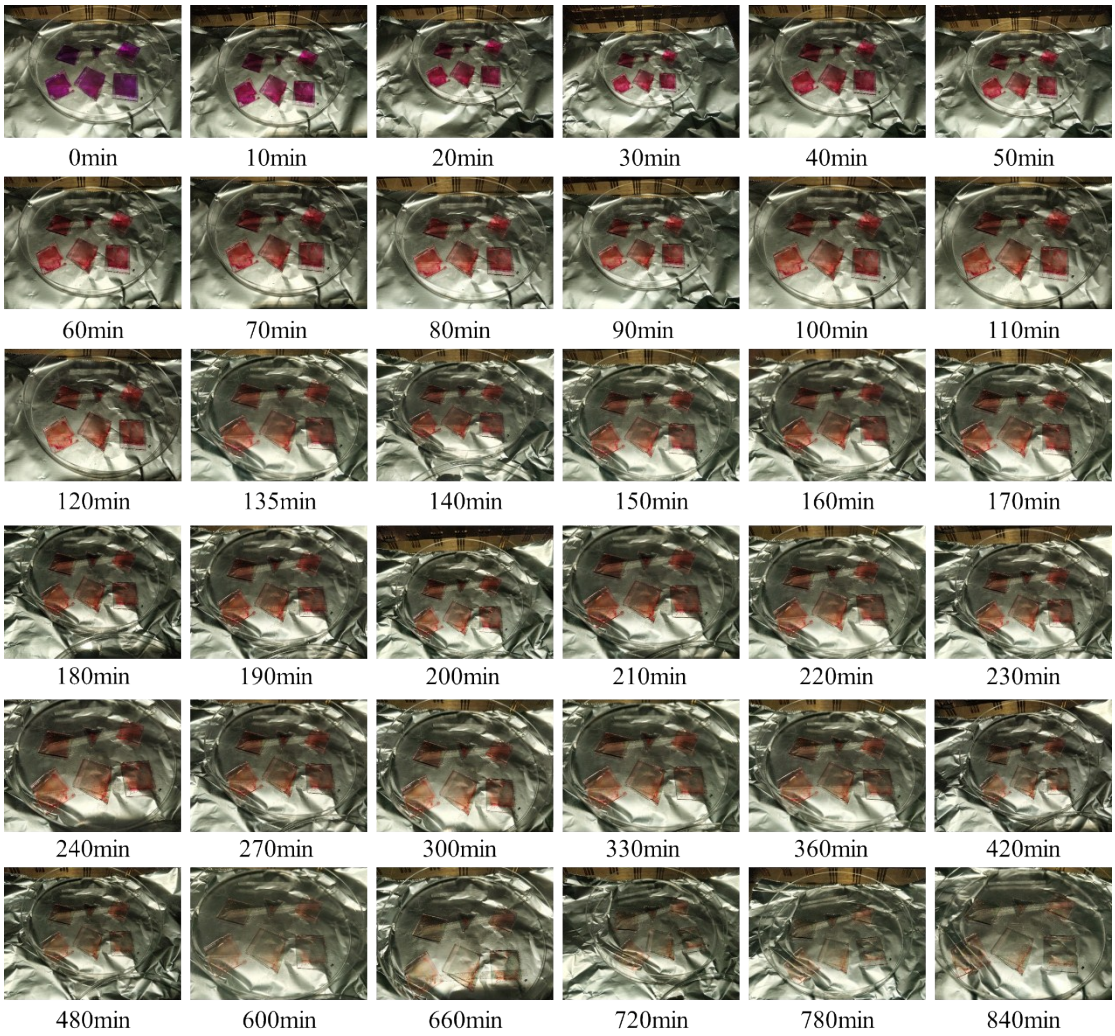

Figure S10 Photos of films NTO-A, NTO-A+R, NTO-R, TiO_2-A， TiO_2-A+R and TiO_2-R during long-term irradiation

12. TEM images for large anatase crystal grain and grain boundary

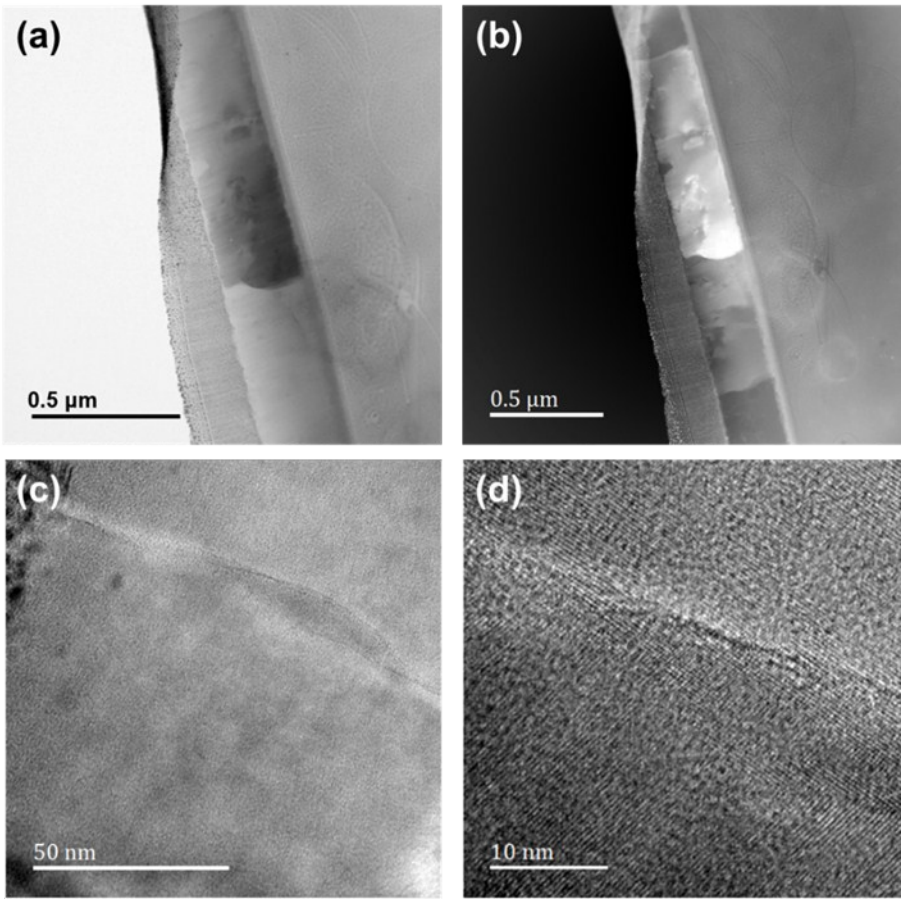

Figure S11 (a) & (b) Light and dark field TEM images with larger scale; (c) & (d) smaller scale TEM images shown with grain boundary.