Supplementary Information

A synergistic interaction between isolated Au nanoparticles with oxygen vacancies in amorphous black TiO_2 nanoporous film: toward enhanced photoelectrochemical water splitting

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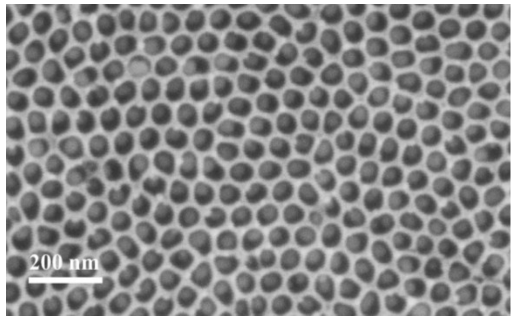

Figure S1. SEM image of the Au@TiO_2 nanoporous film.

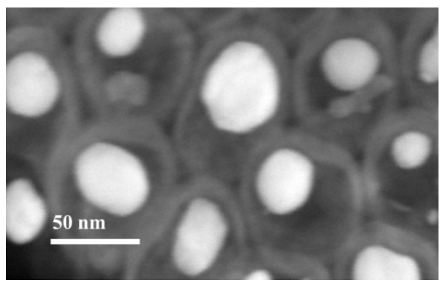

Figure S2. STEM image of the Au@A-B-TiO_2 nanoporous film.

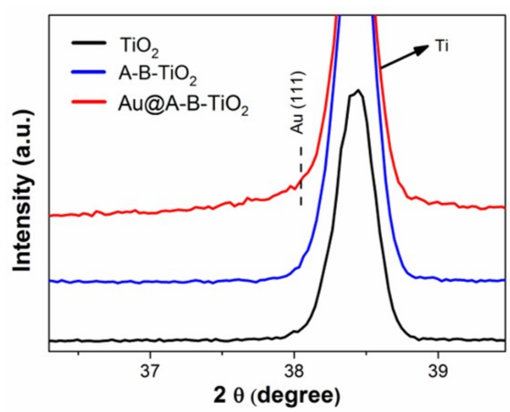

Figure S3. Magnified XRD patterns of TiO_2 nanoporous film, A-B-TiO_2 nanoporous film and Au@A-B-TiO_2 nanoporous film.

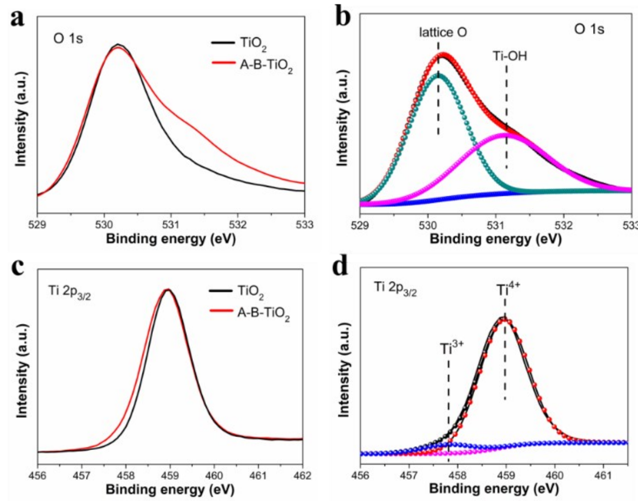

Figure S4. (a) High-resolution XPS O 1s peaks of TiO_2 and A-B-TiO_2. (b) High-resolution XPS O 1s peak of A-B-TiO_2. (c) High-resolution XPS Ti $2p_{3/2}$ peaks of TiO_2 and A-B-TiO_2. (d) High-resolution XPS Ti $2p_{3/2}$ peak of A-B-TiO_2.

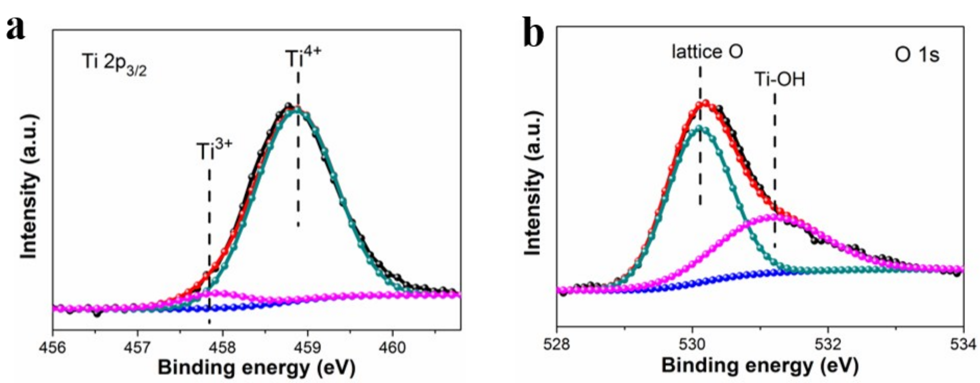

Figure S5. High-resolution XPS (a) Ti $2p_{3/2}$ peak and (b) O 1s peak of Au@A-B-TiO_2.

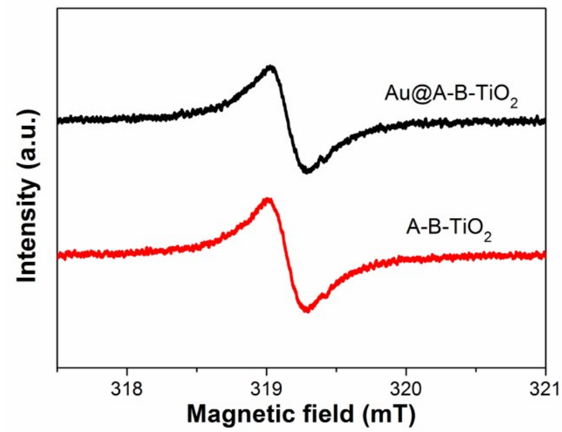

Figure S6. ESR spectra of A-B-TiO_2 and Au@A-B-TiO_2.

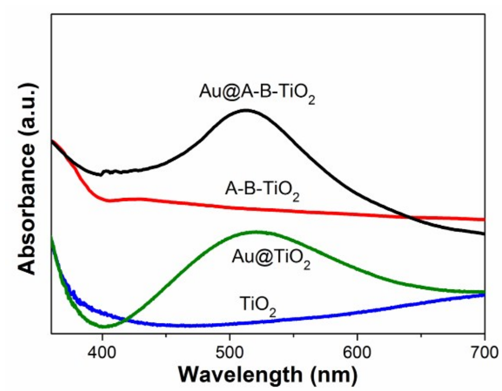

Figure S7. UV-vis absorption spectra of TiO_2, Au@TiO_2, A-B-TiO_2, and Au@A-B-TiO_2.

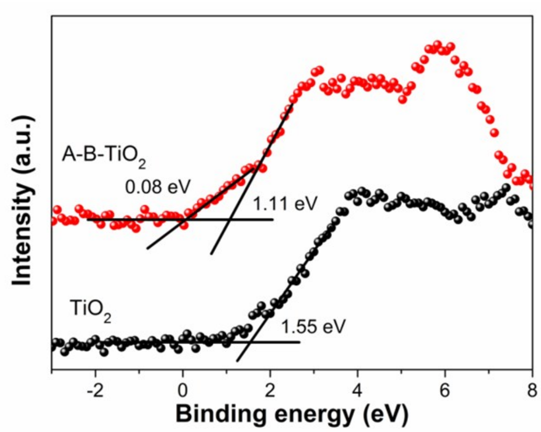

Figure S8. VB-XPS spectra of TiO_2 and A-B-TiO_2.

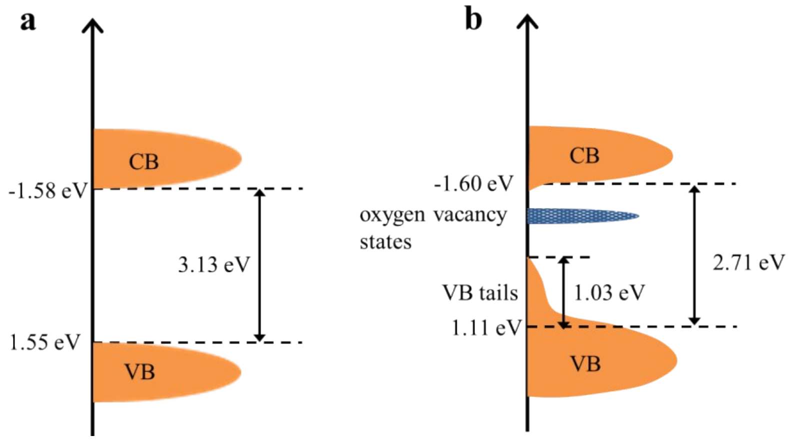

Figure S9. Band energy diagram of (a) TiO_2 and (b) A-B-TiO_2.

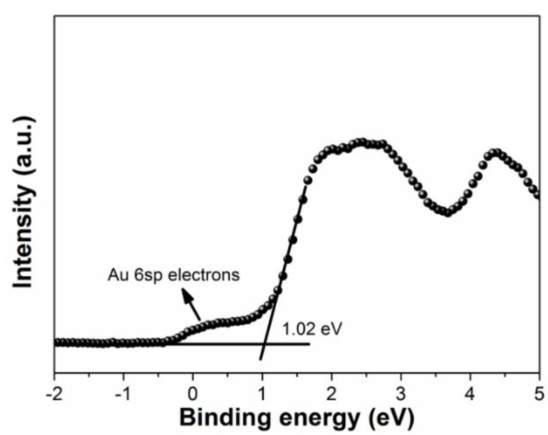

Figure S10. VB-XPS spectra of Au@A-B-TiO_2.

Because Au@A-B-TiO_2 is a composite material, the VB-XPS spectrum of Au@A-B-TiO_2 can give the information of both Au and A-B-TiO_2. The binding energy near the Fermi levels can be attributed to Au 6sp electrons. And the binding energy at 1.02 eV is related to the VB of A-B-TiO_2. The slight difference of VB between A-B-TiO_2 in Au@A-B-TiO_2 (1.02 eV) and bare A-B-TiO_2 (1.11 eV) may be due to the slight band bending and alignment of Fermi levels after formation of hybrid structure. It is difficult to determine the band tail of A-B-TiO_2 in Au@A-B-TiO_2 from the VB-XPS spectra because it will overlap the Au 6sp electrons.

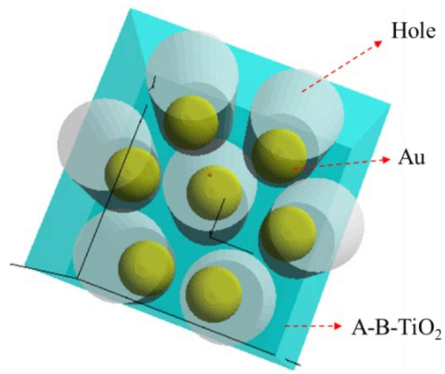

Figure S11. Structure model of Au@A-B-TiO_2 heterostructure for the FDTD simulation.

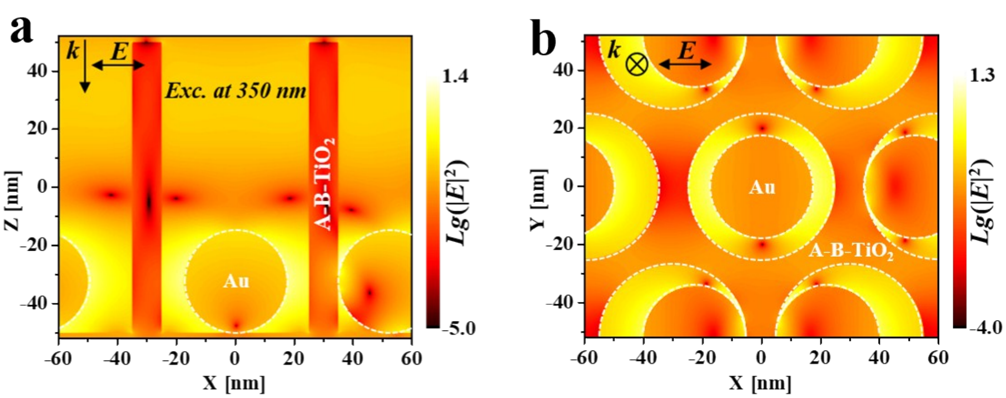

Figure S12. Spatial distribution of the enhancement of electromagnetic field intensity at wavelengths of 350.

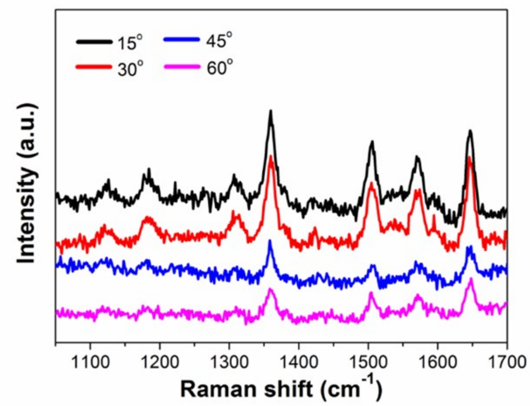

Figure S13. Angle-resolved SERS spectra of Au@A-B-TiO_2.

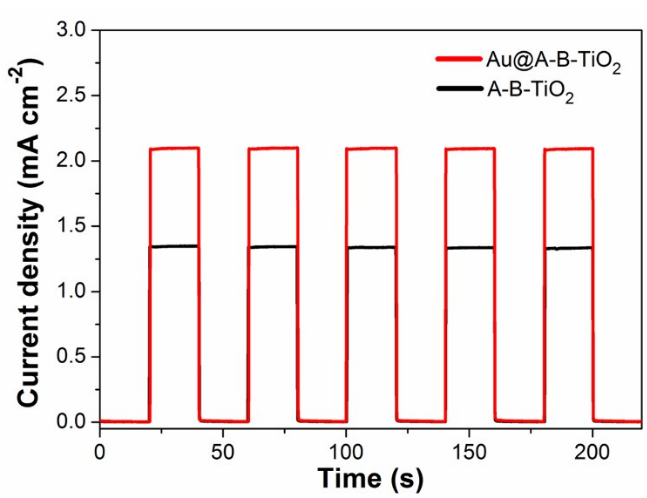

Figure S14. Transient photocurrent responses of A-B-TiO_2 and Au@A-B-TiO_2 photoelectrodes measured at 1.23 V vs RHE under UV light.

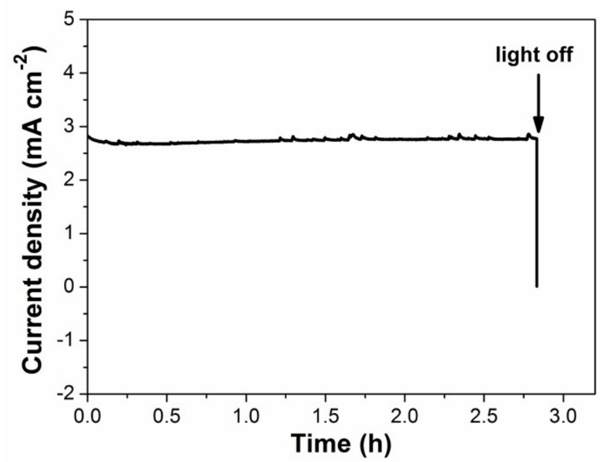

Figure S15. Longtime photocurrent of Au@A-B-TiO_2 measured at 1.23 V vs RHE under AM 1.5G illumination.

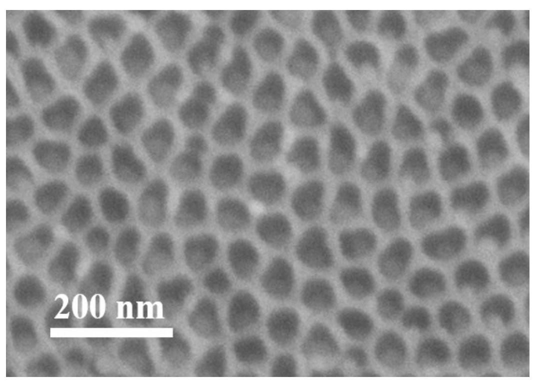

Figure S16. SEM image of Au@A-B-TiO_2 after long time photocurrent measurement.

Table S1. PEC water splitting performance comparison of different Au-TiO_2 based photoanodes.

Photoelectrodes	Electrolyte / Light source	Photocurrent at 1.23 V vs RHE / maximum photoconversion efficiency	Reference
Au@A-B-TiO_2	**1 M KOH aqueous solution / AM 1.5G**	**2.82 mA cm^{-2} / 1.27%**	**This work**
Au/TiO_2 NTPC	1 M KOH aqueous solution / AM 1.5G	2.25 mA cm^{-2} / 1.1%	1
Au/TiO_2 NRPCs	1 M KOH aqueous solution / AM 1.5G	~1.6 mA cm^{-2} / 0.7%	2
Au -decorated TiO_2	1 M KOH aqueous solution / AM 1.5G	~1.7 mA cm^{-2}	3
Au/TiO_2 BNRs	1 M KOH aqueous solution / AM 1.5G	~2.32 mA cm^{-2} / 1.2%	4
Au NR/TiO_2	1 M potassium borate / AM 1.5G	0.15 mA cm^{-2} at 0.6 V vs RHE	5
LE-Au/TNTs	1 M KOH aqueous solution / AM 1.5G	1.48 mA cm^{-2} / 0.81%	6
Au/H-TiO_2	1 M KOH aqueous solution / AM 1.5G	1.99 mA cm^{-2} / 0.687%	7
AuNP/GQD@TNR	1 M NaOH aqueous solution / AM 1.5G	1.75 mA cm^{-2}	8
AZO/TiO_2 /Au NCA	0.1 M Na_2SO_4 solution / AM 1.5G	~1.0 mA cm^{-2} / 0.7%	9
TONT-Al_2O_3-Au	1 M KOH aqueous solution / AM 1.5G	~0.7 mA cm^{-2}	10
Au/B-TiO_2	0.5 M Na_2SO_4 solution / 500 W Xe lamp	~2.5 mA cm^{-2} / 0.6%	11

References

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