Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Gas-phase Synthesis of Hybrid Nanostructured Materials

*Min Ling, Christopher S. Blackman**

Dr. Min Ling and Dr. Christopher S. Blackman
Department of Chemistry, University College London, 20 Gordon Street, London WC1H 0AJ, United Kingdom
E-mail: c.blackman@ucl.ac.uk

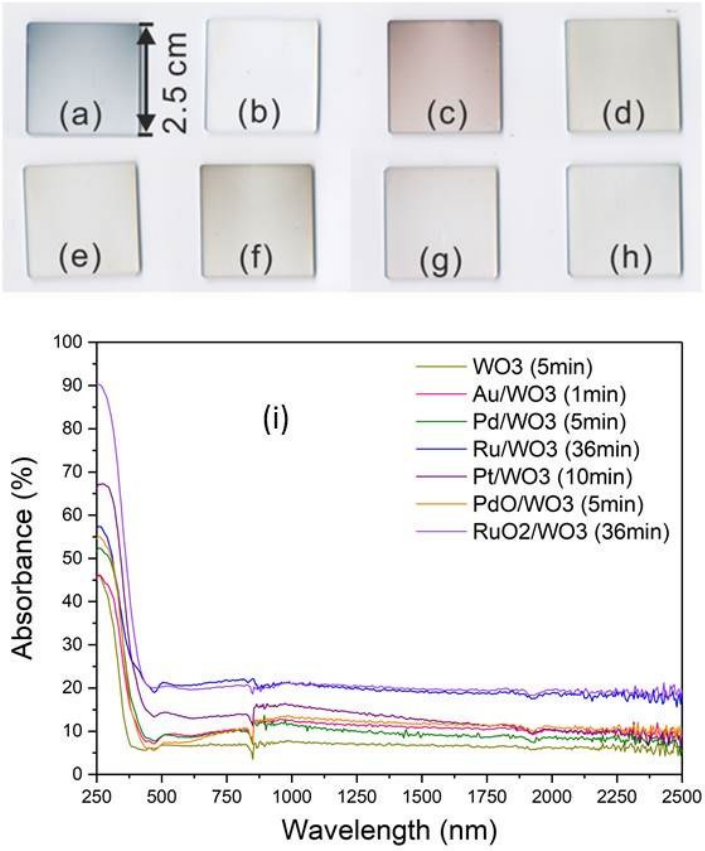

Figure S 1. The photographs of thin films (a) $WO_{2.63}$, (b) WO_3, (c) Au/WO_3 (1 min), (d) Pt/WO_3 (10 min), (e) Pd/WO_3 (5 min), (f) Ru/WO_3 (36 min), (g) PdO/WO_3 (5 min), (h) RuO_2/WO_3 (36 min) on quartz and (i) absorbance spectrum of corresponding samples.

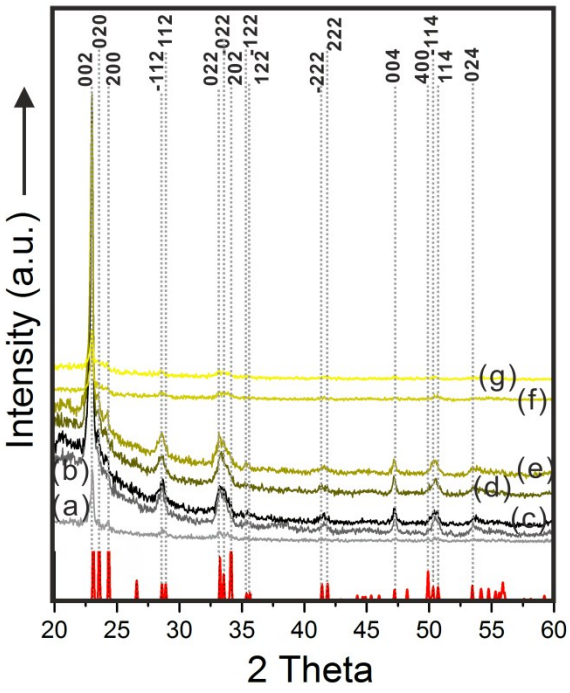

Figure S 2. XRD patterns of (a) WO_3, (b) Au/WO_3 (1 min), (c) Pt//WO_3 (10 min), (d) Pd/WO_3 (5 min), (e) Ru/WO_3 (36 min), (f) PdO/WO_3 (5 min) and (g) RuO_2/WO_3 (36 min) with matches the monoclinic WO_3 reference pattern (red colour) (PDF 072-0677, *a*=7.306, *b*=7.540, *c*=7.692 Å and *α*=90 °, β=90.881°, *γ*=90 °).

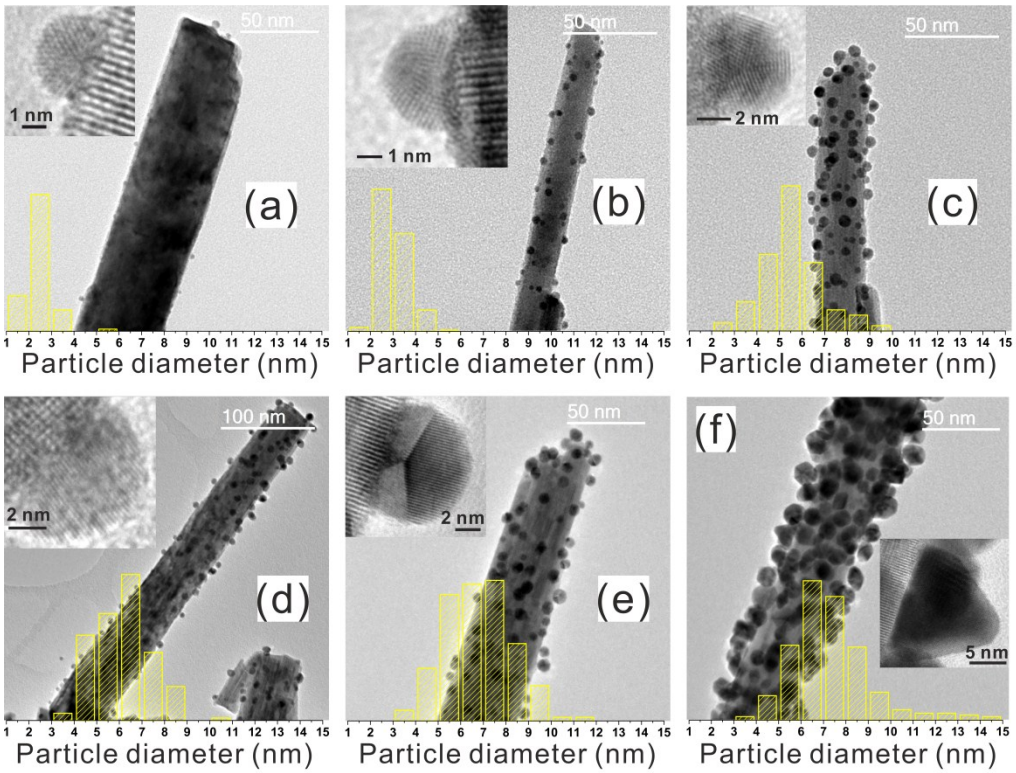

Figure S 3. TEM images of Au/WO_3 hybrid nanostructure thin film: (a) Au/WO_3 (0.5 min), (b) Au/WO_3 (1 min), (c) Au/WO_3 (5 min), (d) Au/WO_3 (10 min), (e) Au/WO_3 (20 min), (f) Au/WO_3 (35 min) with Au NP size distributions on WO_3 NR and insect zoom-in images of Au NP.

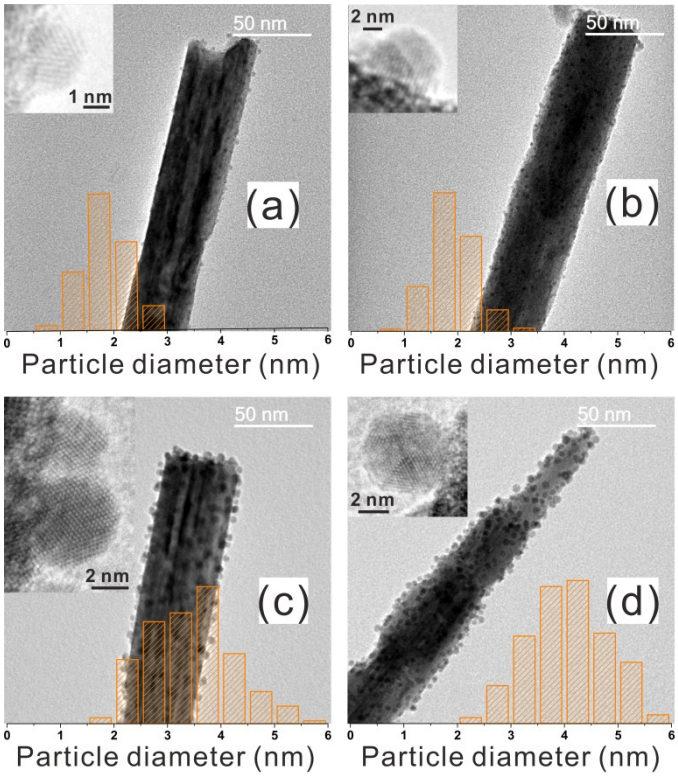

Figure S 4. TEM images of Pd/WO_3 hybrid nanostructure thin film: (a) Pd/WO_3 (5 min), (b) Pd/WO_3 (10 min), (c) Pd/WO_3 (20 min), (d) Pd/WO_3 (35 min) with Pd NP size distributions on WO_3 NR and insect zoom-in images of Pd NP.

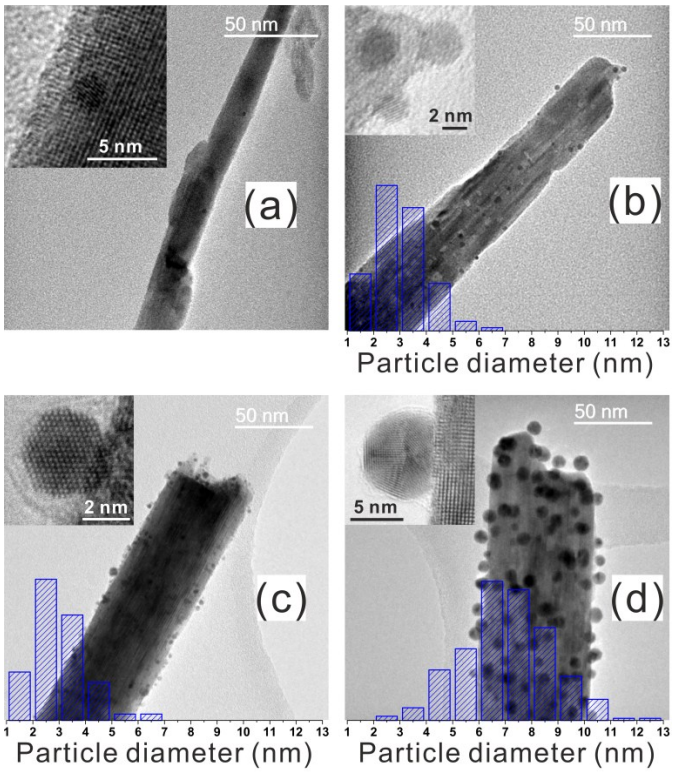

Figure S 5. TEM images of Pt/WO_3 hybrid nanostructure thin film: (a) Pt/WO_3 (1 min), (b) Pt/WO_3 (5 min), (c) Pt/WO_3 (10 min), (d) Pt/WO_3 (20 min) with Pt NP size distributions on WO_3 NR and insect zoom-in images of Pt NP.

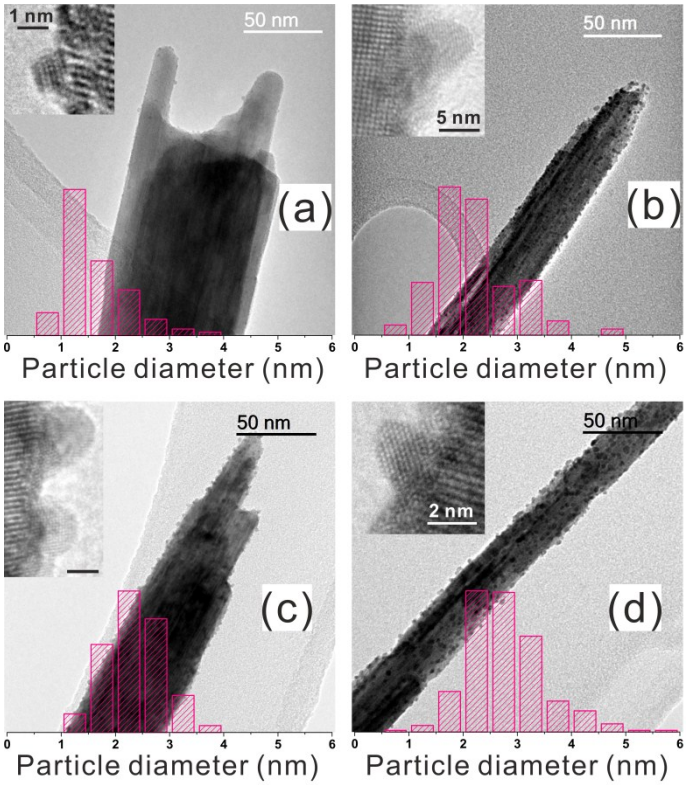

Figure S 6. TEM images of Ru/WO_3 hybrid nanostructure thin film: (a) Ru/WO_3 (1 min), (b) Ru/WO_3 (10 min), (c) Ru/WO_3 (20 min), (d) Ru/WO_3 (36 min) with Ru NP size distributions on WO_3 NR and insect zoom-in images of Ru NP.

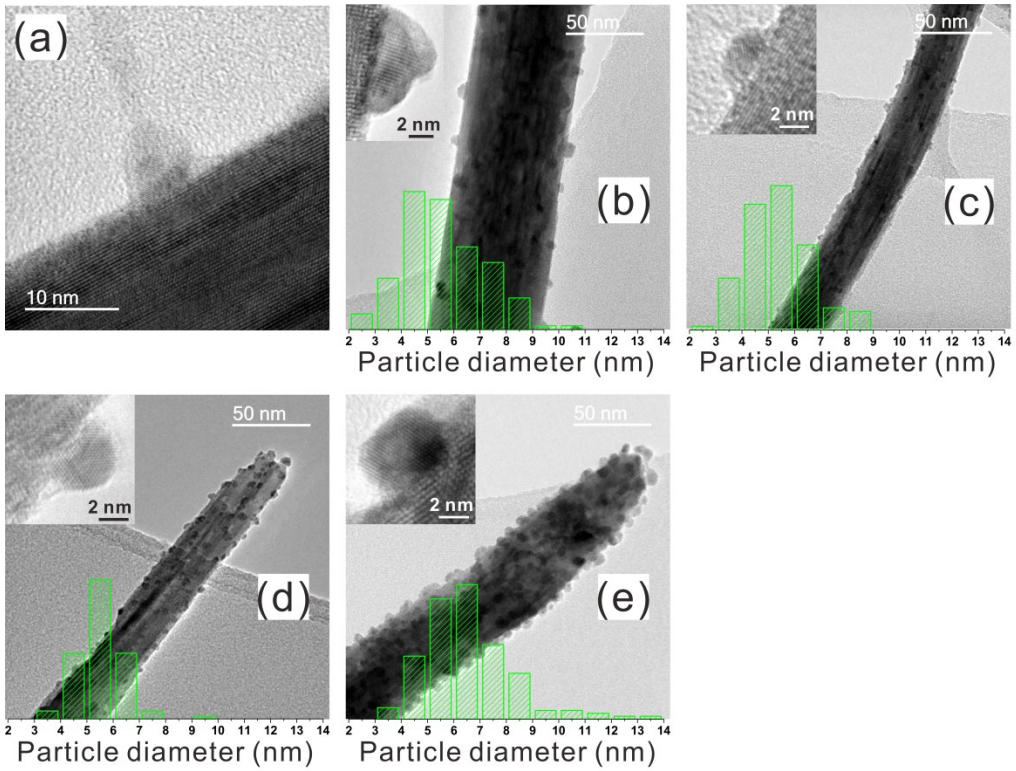

Figure S 7. TEM images of PdO/WO_3 hybrid nanostructure thin film: (a) PdO/WO_3 (1 min), (b) PdO/WO_3 (5 min), (c) PdO/WO_3 (10 min), (d) PdO/WO_3 (20 min), (e) PdO/WO_3 (35 min) with PdO NP size distributions on WO_3 NR and insect zoom-in images of PdO NP.

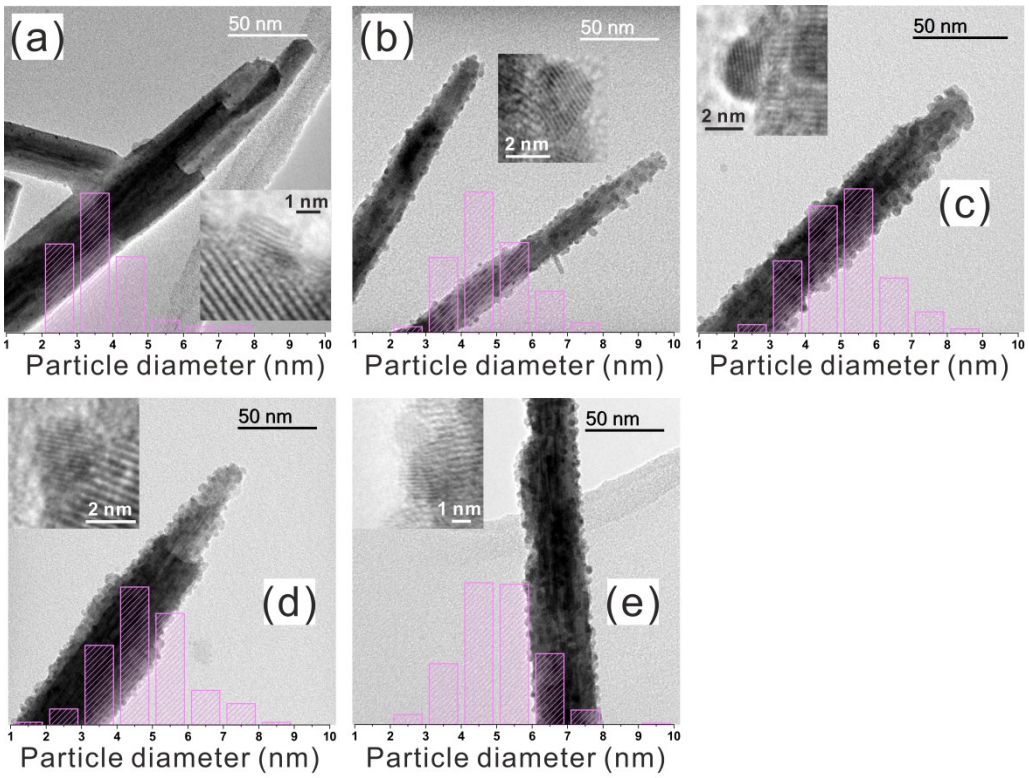

Figure S 8. TEM images of RuO_2/WO_3 hybrid nanostructure thin film: (a) RuO_2/WO_3 (1 min), (b) RuO_2/WO_3 (5 min), (c) RuO_2/WO_3 (10 min), (d) RuO_2/WO_3 (20 min), (e) RuO_2/WO_3 (36 min) with RuO_2 NP size distributions on WO_3 NR and insect zoom-in images of RuO_2 NP.

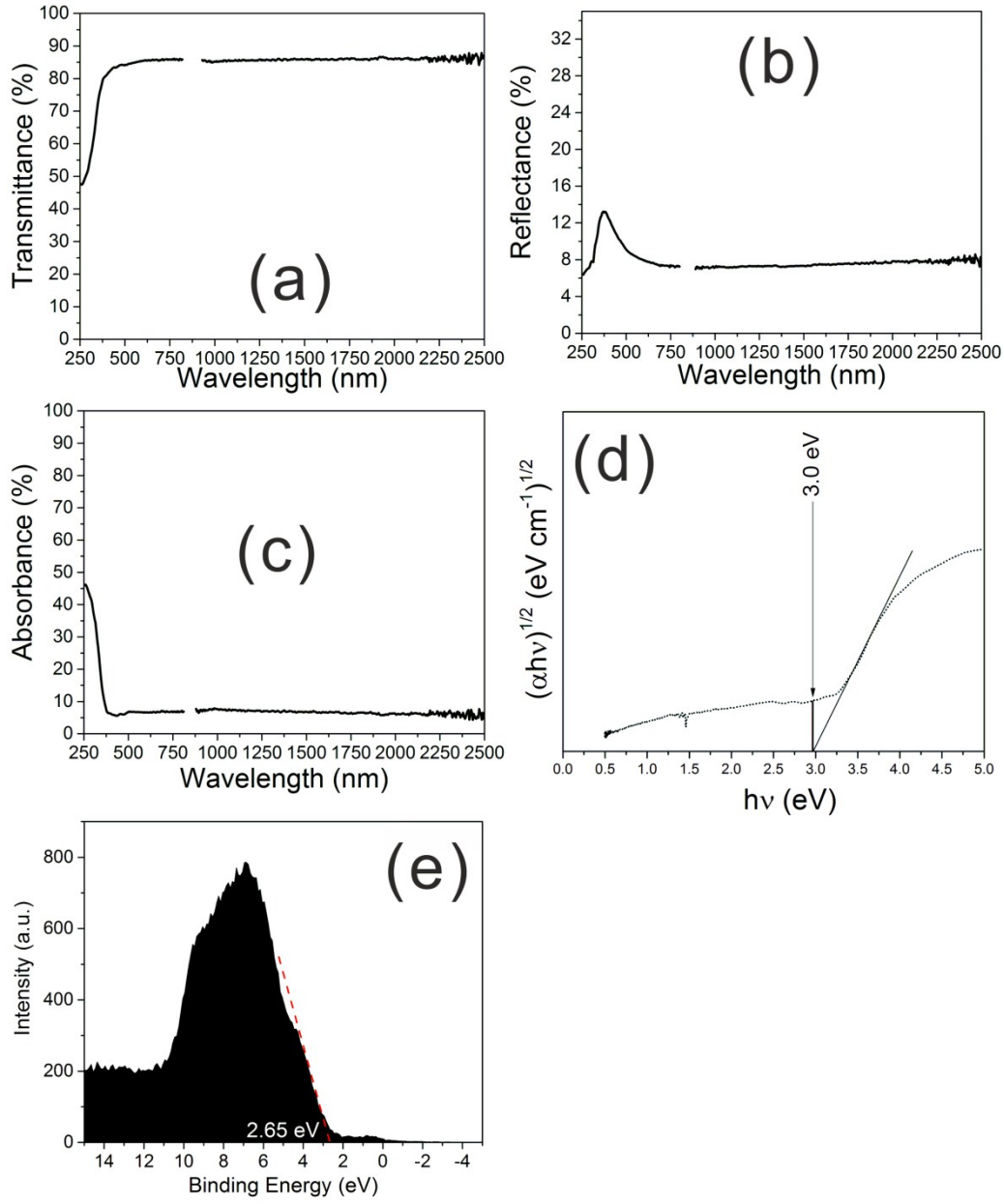

Figure S 9. The transmittance (a), reflectance (b) and absorbance (c) spectrum (aberrant data due to grating change of the UV-Vis spectrometer has been removed) of undecorated WO_3 NR arrays thin film was used to calculate their bandgap (d, indirect) of 3.0 eV by tauc plots. XPS spectra for the valance band of undecorated WO_3 NR arrays thin film (e) with reference C1s peak calibrated to 284.8 eV.

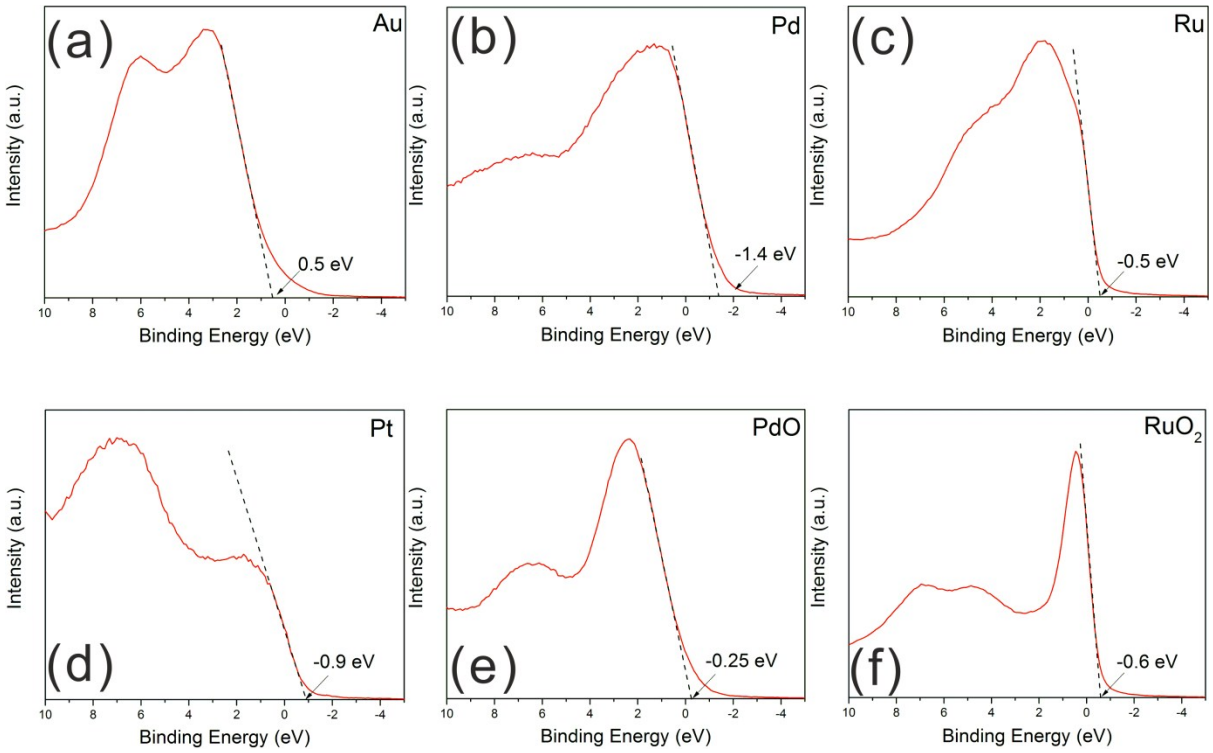

Figure S 10. The XPS valence band region of (a) Au, (b) Pd, (c) Ru, (d) Pt, (e) PdO and (f) RuO_2 thin films were deposited on quartz substrate for 45 min *via* AACVD, respecting to fermi level (BE=0 eV) and referencing to C 1s (284.8 eV).

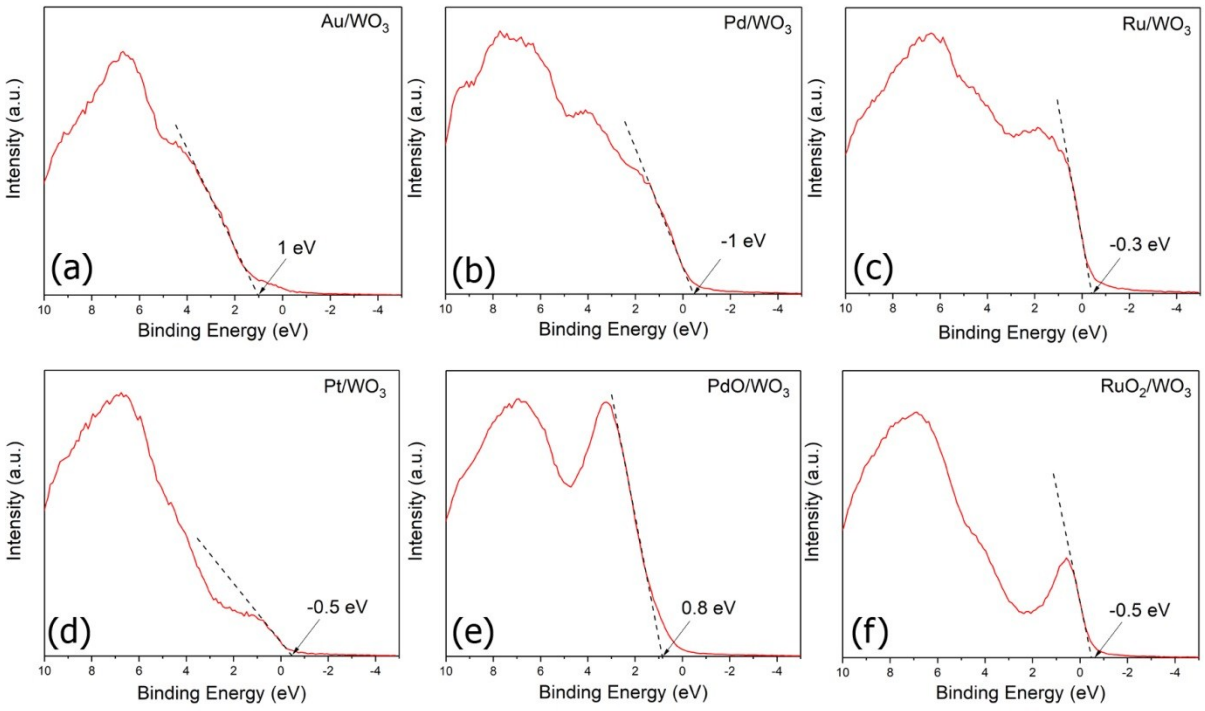

Figure S 11. The XPS valence band region of (a) Au/WO3 (1 min), (b) Pd/WO3 (5 min), (c) Ru/WO3 (36 min), (d) Pt/WO3 (10 min), (e) PdO/WO3 (5 min), (f) RuO2/WO3 (36 min), respecting to fermi level (BE=0 eV) and referencing to C 1s (284.8 eV).

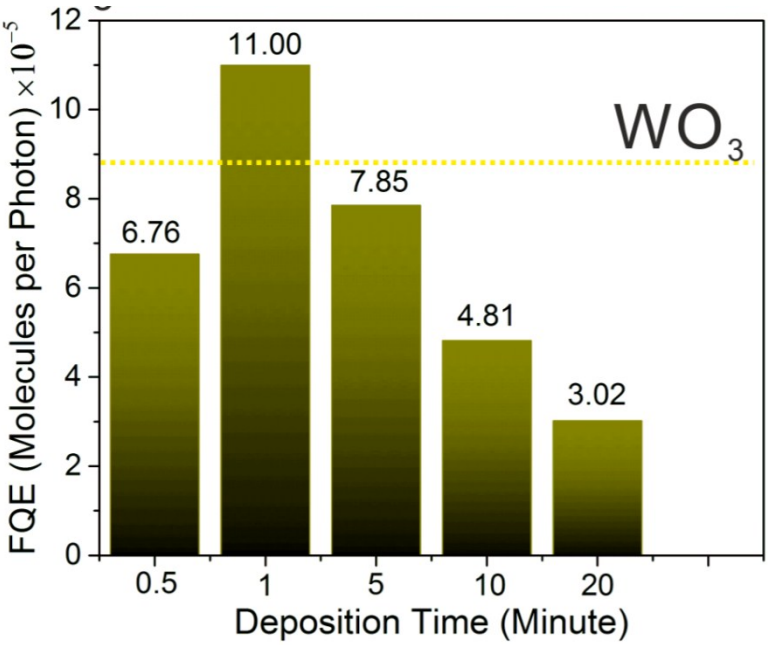

Figure S 12. The photocatalytic activity of Au/WO_3 thin films deposited for various time evaluated by formal quantum efficiencies (b), given as degraded SA molecules by per incident photon in unit (molecule photon^{-1}), were calculated from the initial rates of photodegradation of SA (a)), compared to undecorated WO_3 NR thin films (FQE = 8.67×10^{-5}).

Table S 1. XPS quantification of sample Pd/WO_3 (5 min), Ru/WO_3 (36 min) and RuO_2/WO_3 (36 min) based on figure 5c, d and f analysed via software *CasaXPS (Version 2.3.16 PR 1.6)*.

Sample	Component	Peak	Position (/eV)	FWHM	Area	R.S.F	At% Conc.
Pd/WO3 (5 min)	Pd metal	3d5/2	335.8	1.300	5484.65	16	43.54
		3d3/2	341.0	1.300	3657.21	16	29.03
	PdCl2	3d5/2	338.3	2.076	2072.43	16	16.45
		3d3/2	343.1	2.076	1381.93	16	10.97
Ru/WO3 (36 min)	C	1 s	284.8	0.500	15794.91	1	33.45
	Ru metal	3d5/2	280.1	0.759	108699.32	12.5	18.41
		3d3/2	284.2	0.759	72486.70	12.5	12.28
	RuO2	3d5/2	280.7	1.300	126991.18	12.5	21.51
		3d3/2	284.7	1.300	15794.91	12.5	14.35
RuO2/WO3 (36 min)	C	1 s	284.8	0.794	25798.51	1	52.31
	RuO2	3d5/2	280.8	0.902	70865.15	12.5	11.49
		3d3/2	285.2	0.902	47255.98	12.5	7.66
	RuO3	3d5/2	282.6	2.979	105541.82	12.5	17.12
		3d3/2	286.5	2.979	70380.86	12.5	11.42