

Supplementary Information

One-step photochemical deposition of PdAu alloyed nanoparticles on TiO₂ nanowires for ultra-sensitive H₂ detection

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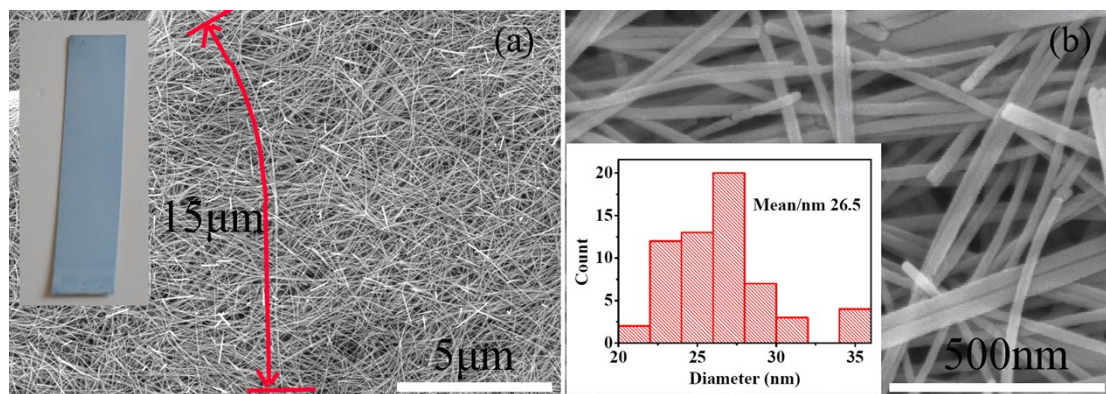


Fig. S1 SEM pictures of bare TiO₂ nanowires on the Ti foil substrate, and the insets in both panels are the photograph picture of TiO₂ nanowire film and their diameter histogram, respectively.

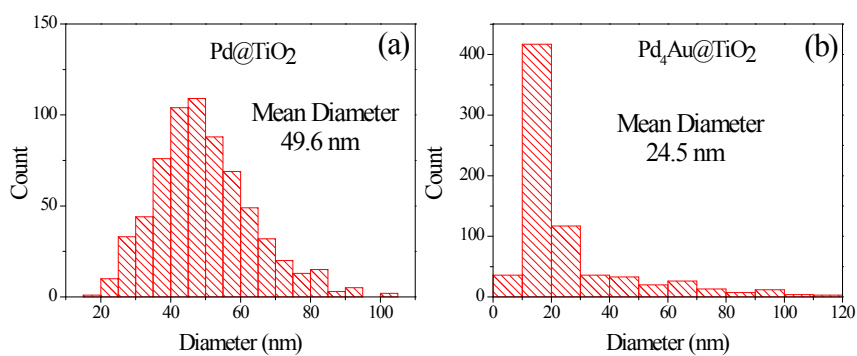


Fig. S2 Diameter histogram of Pd NPs in Pd@TiO₂ nanowires (a) and Pd₄Au NPs in Pd₄Au@TiO₂ nanowires (b).

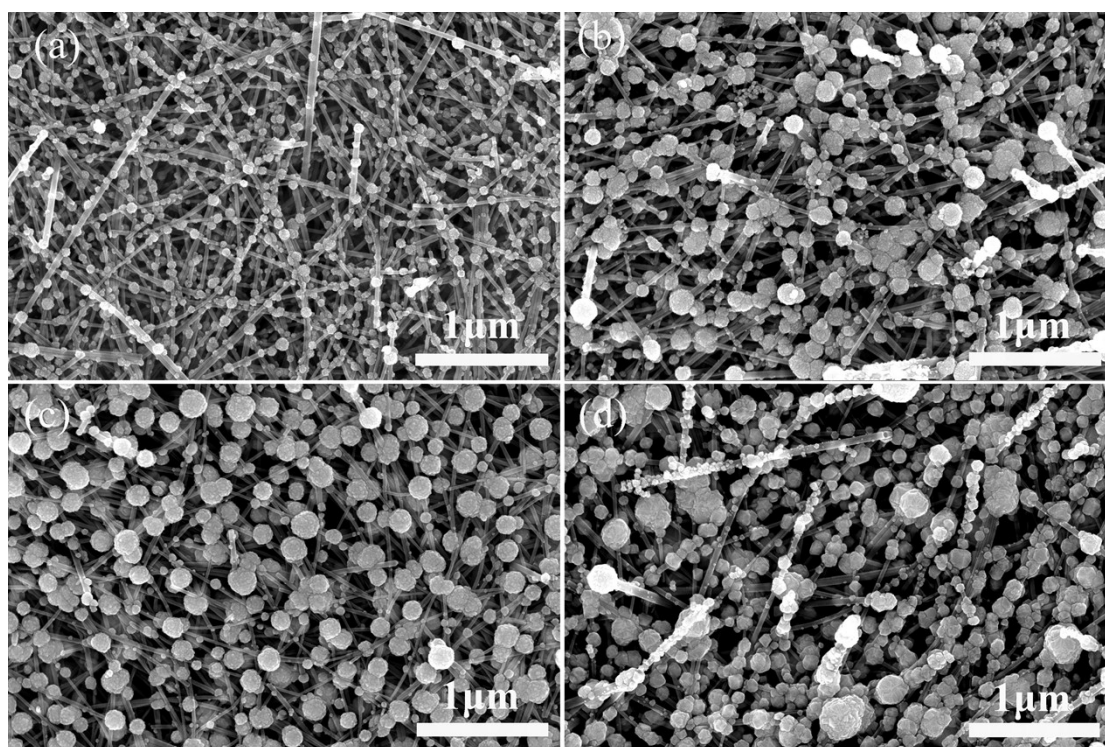


Fig. S3 SEM pictures of PdAu@TiO₂ with molar ratio of Pd²⁺/Au³⁺ = 8 (a), Pd²⁺/Au³⁺ = 2 (b), Pd²⁺/Au³⁺ = 1 (c), and (d) photodeposition time prolonging to 60 min with Pd²⁺/Au³⁺ = 4 in precursor solution.

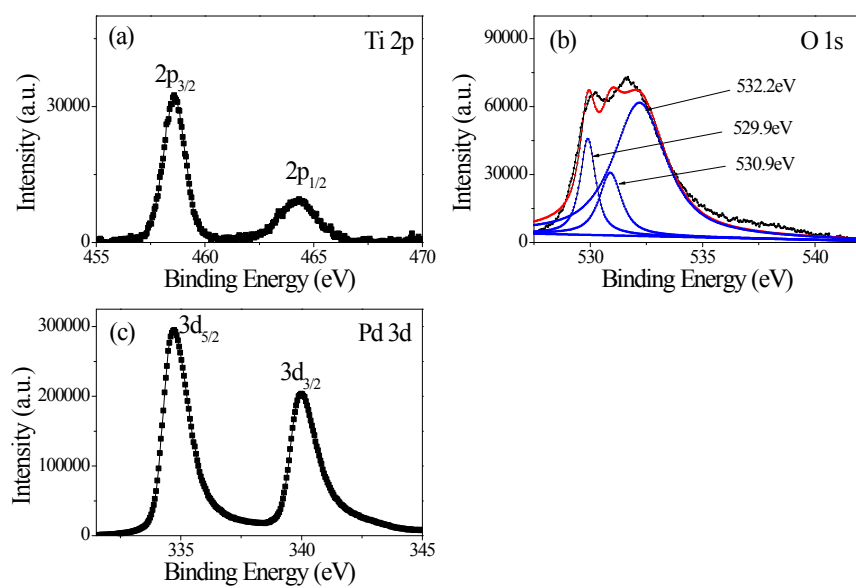


Fig. S4 XPS spectra of Ti 2p (a), O 1s (b) and Pd 3d (c) in Pd@TiO₂.

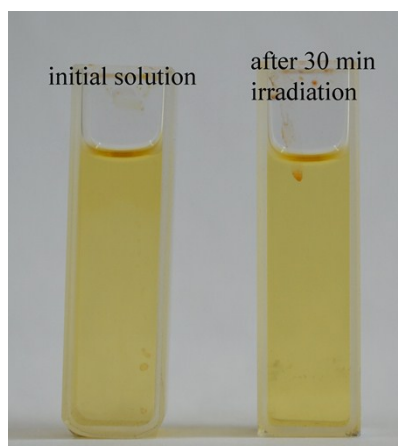


Fig. S5 Photograph pictures of PdCl₂ solution before and after UV irradiation for 30 min.

The estimation of precursor consumption in the photodeposition process

We take Pd@TiO₂ sample as an example to estimate the consumption amount of the precursor. As shown in Fig. 1(a), the density of Pd NPs loaded on TiO₂ surface is about 111/μm², and the total area of Pd@TiO₂ nanowires film is 5 cm×1 cm×2 (Note: the factor “2” comes from the both sides of the film). Then the quality of total Pd NPs can be drawn according to the following eqs.

$$m = N \cdot \rho \cdot \frac{\pi}{6} D^3$$

Where N is the quantity of total Pd NPs, which is the product of the density of Pd NPs and the area of Pd@TiO₂ nanowires film. ρ is the density of Pd material. D is the mass diameter of Pd NPs, which is drawn form Fig. S2 (a).

So the total quality of Pd NPs is 8.44×10^{-5} gram, and the quality of Pd element in the precursor is 8.48×10^{-4} gram. Then only 9.95% of precursor is reduced during Pd NPs photodeposition onto the TiO₂ substrate. The similar procedure is used to estimate the effect of the irradiation time. We take Pd₄Au@TiO₂ sample with UV irradiation for 60 min as an example to perform the above calculation, and the reduction rate of 21.8% is realized.

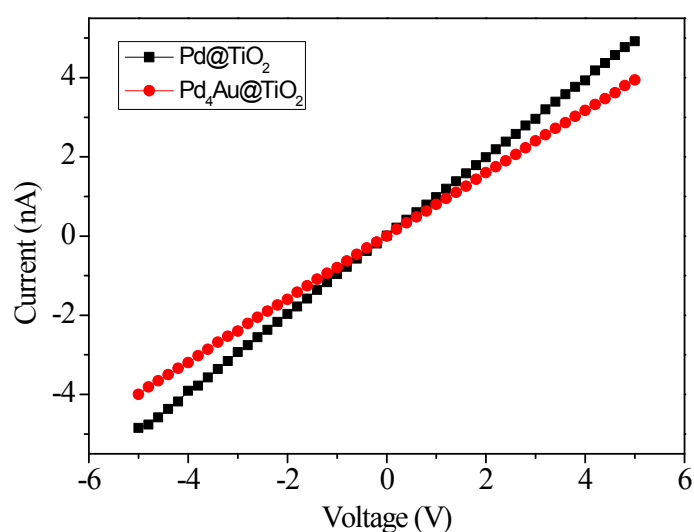


Fig. S6 The I-V curves of Pd@TiO₂ and Pd₄Au@TiO₂ nanowires films

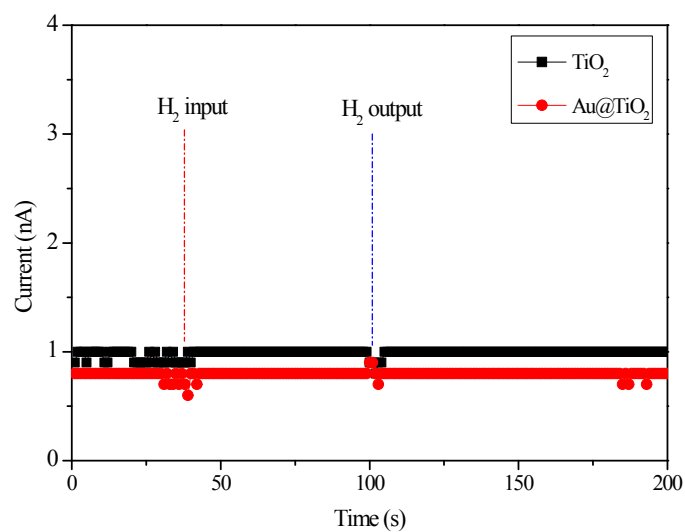


Fig. S7 The response of bare TiO_2 and Au@TiO_2 to 1250 ppm H_2 .

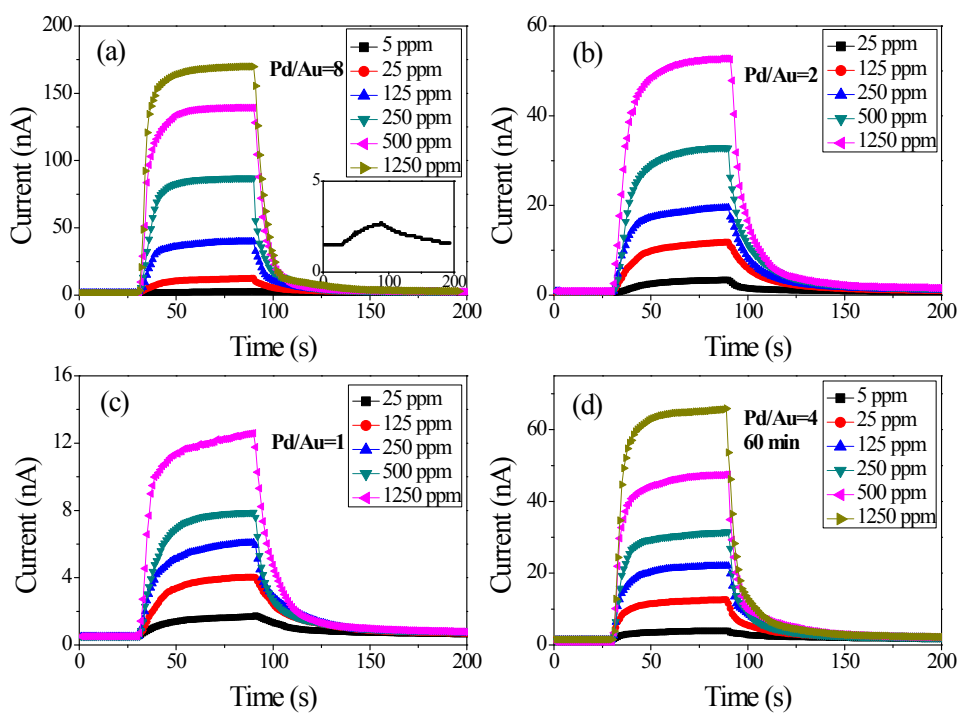


Fig. S8 H_2 response of PdAu@TiO_2 as a function of Pd/Au molar ratio in alloyed NPs and photodeposition time.

Table S1 The sensitivity and response time of PdAu@TiO₂ as a function of Pd/Au atomic ratio and photodeposition time.

H ₂ concentration (ppm)	5	25	125	250	500	1250	
s (%)	Pd/Au=8	200.0	1277.8	4122.2	9577.8	15355.6	18777.8
	Pd/Au=4	350.0	1762.5	6062.5	11662.5	25275.0	44750.0
	Pd/Au=2	※	243.3	1113.3	2138.9	3455.6	5738.9
	Pd/Au=1	※	256.0	714.0	1126.5	1506.5	2454.0
	60 min	333.3	1300.0	2344.4	3400.0	5166.7	7188.9
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τ _r (s)	Pd/Au=8	47	32	20	15	14	10
	Pd/Au=4	21	18	15.5	13.5	12	10
	Pd/Au=2	※	49	32	26	23	19
	Pd/Au=1	※	54	35	30	25	23
	60 min	24	21	18	15	14	12
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Note: ※ denotes no detectable signal.