

Supporting Information

Near-infrared driven photocatalytic hydrogen production from ammonia borane hydrolysis using heterostructure-upconverted nanoparticles

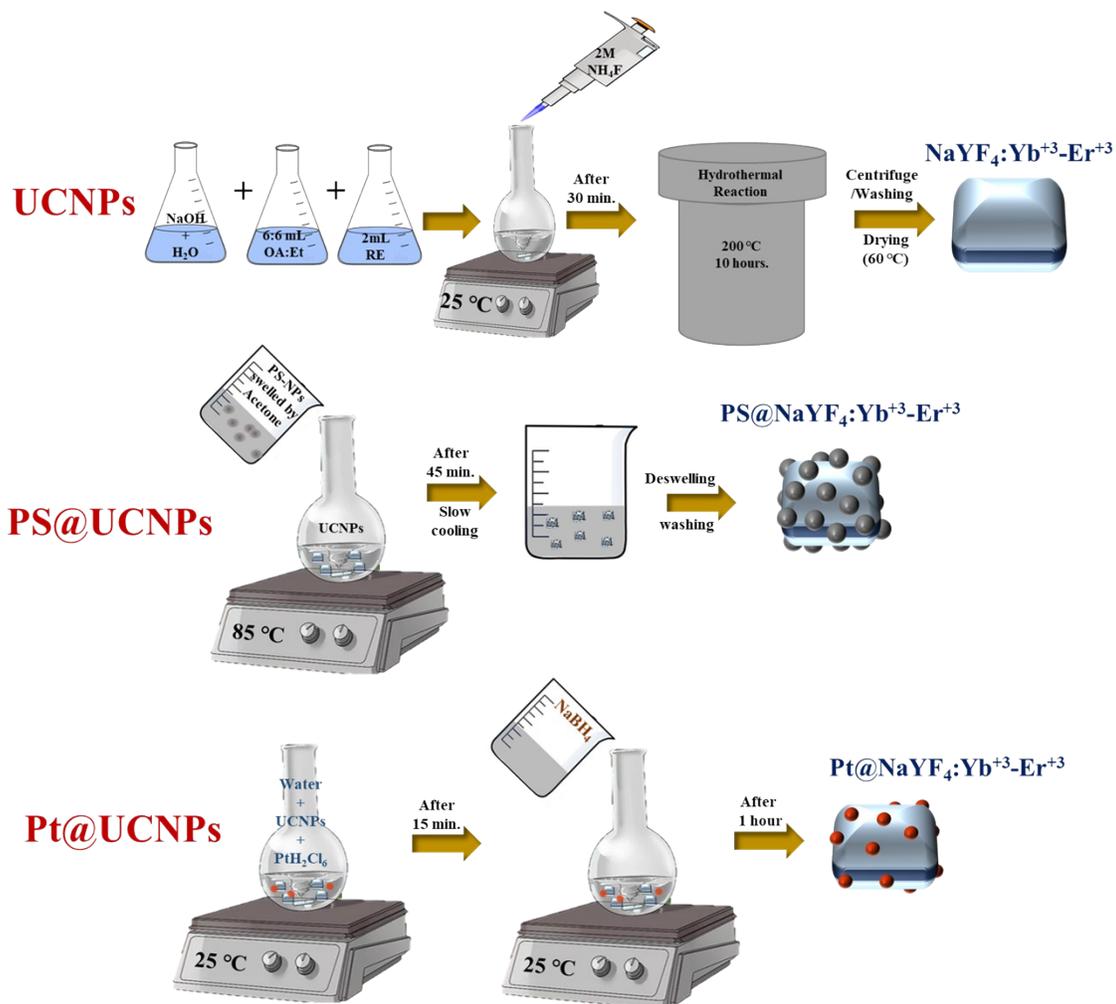
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Schematic S1: Synthesis and fabrication process of heterogenous UCNPs, PS@UCNPs, and Pt@UCNPs.

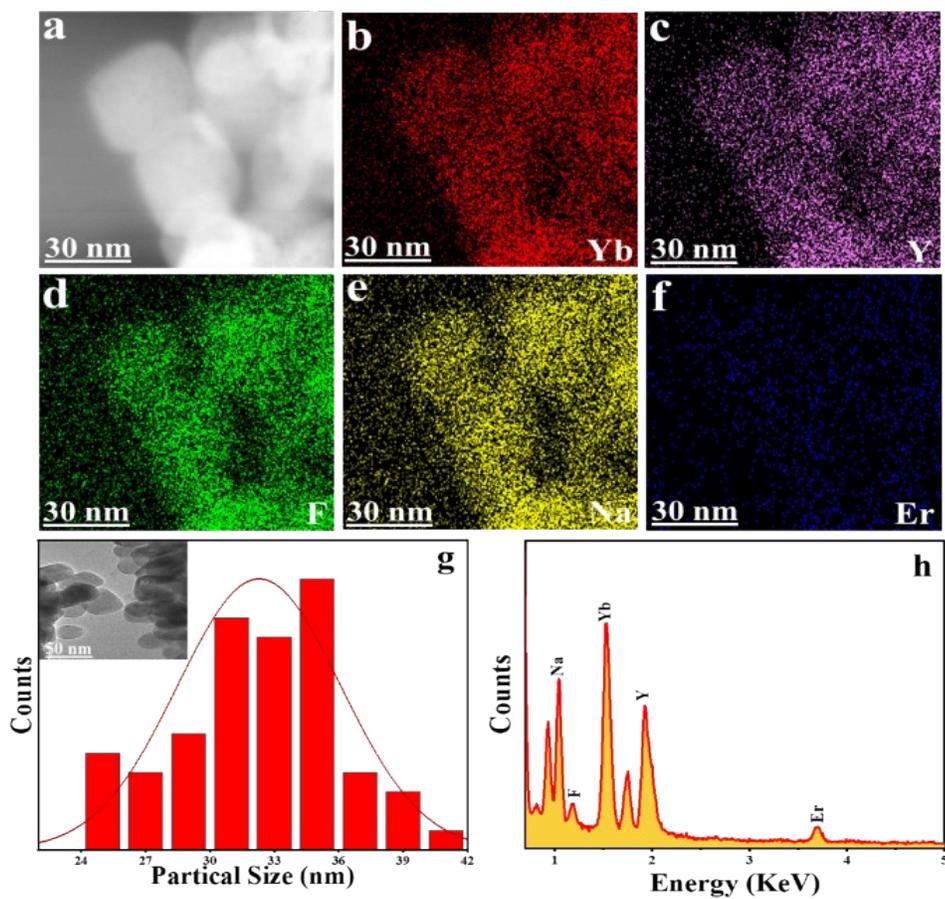


Figure S1: TEM EDX elemental mapping of UCNPs. (a) Nanoparticles TEM image (b) Yb, (c) Y, (d) F, (e) Na, and (f) Er elemental map; (g) particle size distribution along TEM image, (h) EDX elemental graph.

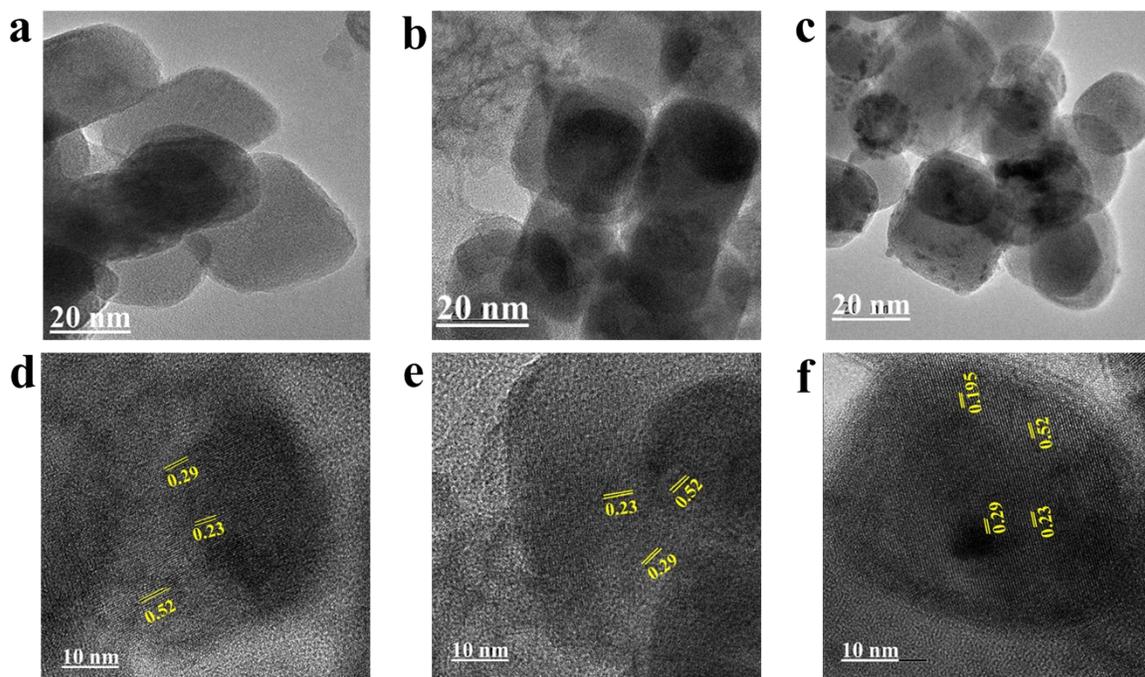


Figure S2: TEM images and interplanar spacing of material. (a) UCNPs, (b) PS@UCNPs (c) Pt@UCNPs, (d) d-spacing of UCNPs, (e) d-spacing of PS@UCNPs, and (f) d-spacing of Pt@UCNPs.

Table S1: interplanar spacing (d-spacing) calculated by XRD planes.

	Peak	2Θ	Θ	$d=n\lambda/2\sin\Theta$
UCNPs / PS@UCNPs	100	17.25	8.62	5.13637066
	110	29.98	14.99	2.97756832
	200	30.97	15.48	2.88516905
	111	38.93	19.46	2.31144436
	201	43.64	21.82	2.07241527
	211	53.76	26.88	1.70373846
Pt@UCNPs	200	46.48	23.24	1.95218507
	111	39.68	19.84	2.26962887
	222	86.67	43.33	1.1224563

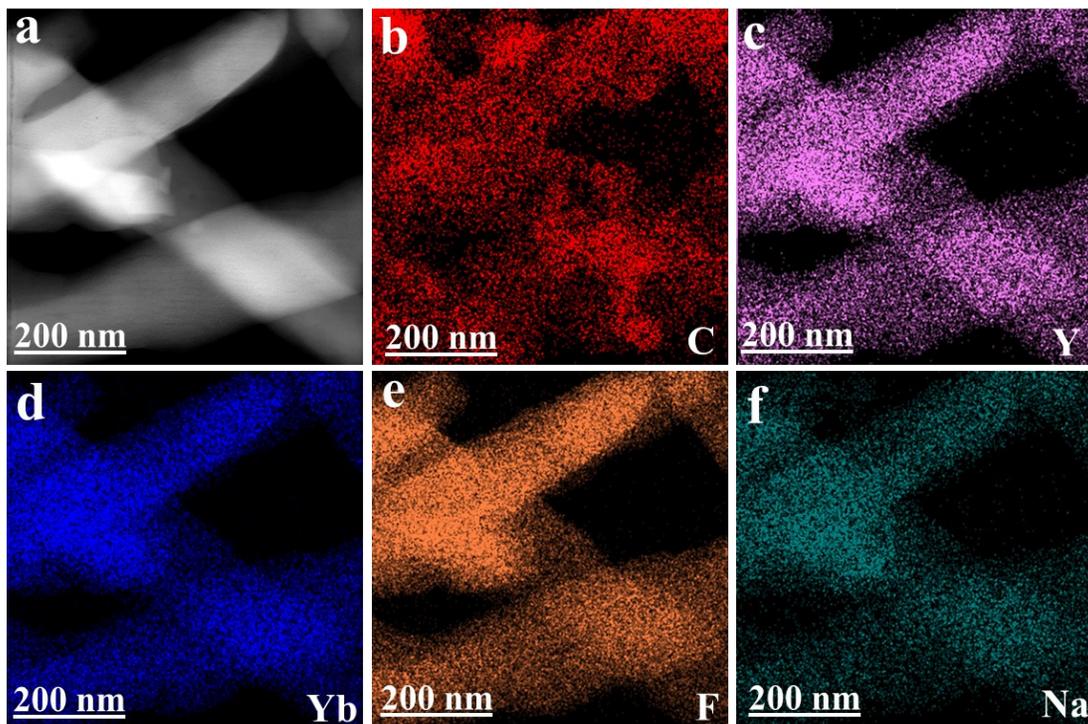


Figure S3: TEM EDX elemental mapping of PS@UCNPs after five cycles. (a) Nanoparticles TEM image (b) C, (c) Y, (d) Yb, (e) F, and (f) Na elemental map.

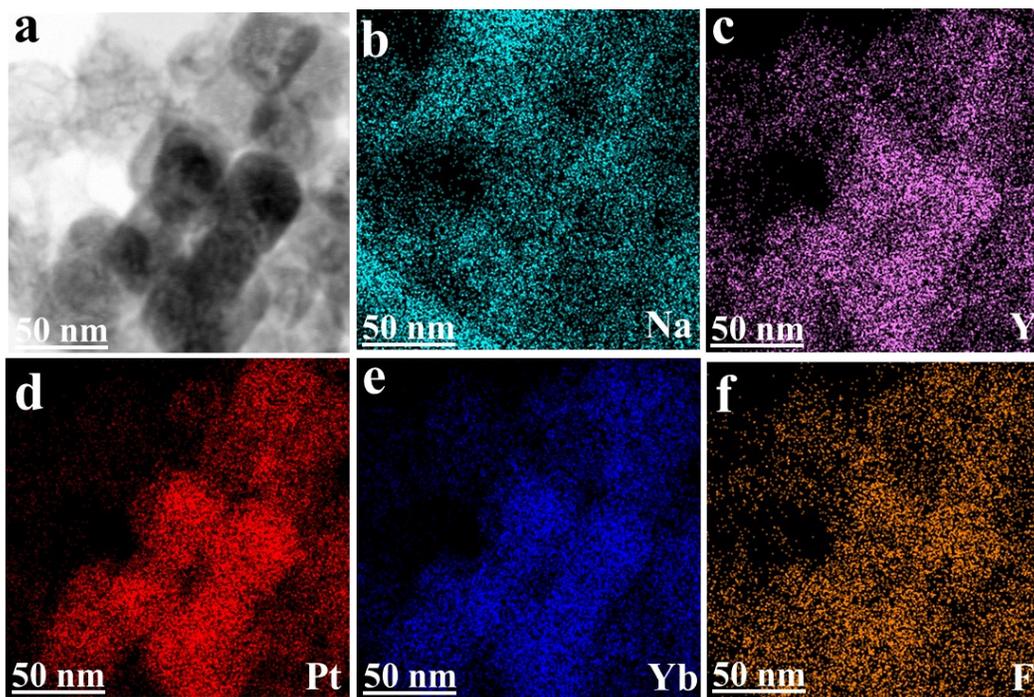


Figure S4: TEM EDX elemental mapping of Pt@UCNPs after five cycles. (a) Nanoparticles TEM image (b) Na, (c) Y, (d) Pt, (e) Yb, and (f) F elemental map.

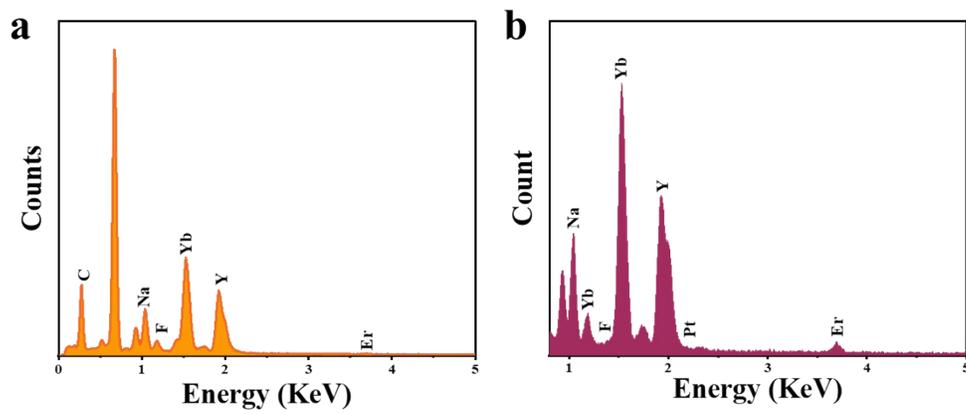


Figure S5: TEM-EDX elemental graph of PS@UCNPs and Pt@UCNPs after five cycles. (a) PS@UCNPs elemental graph, and (b) Pt@UCNPs elemental graph.

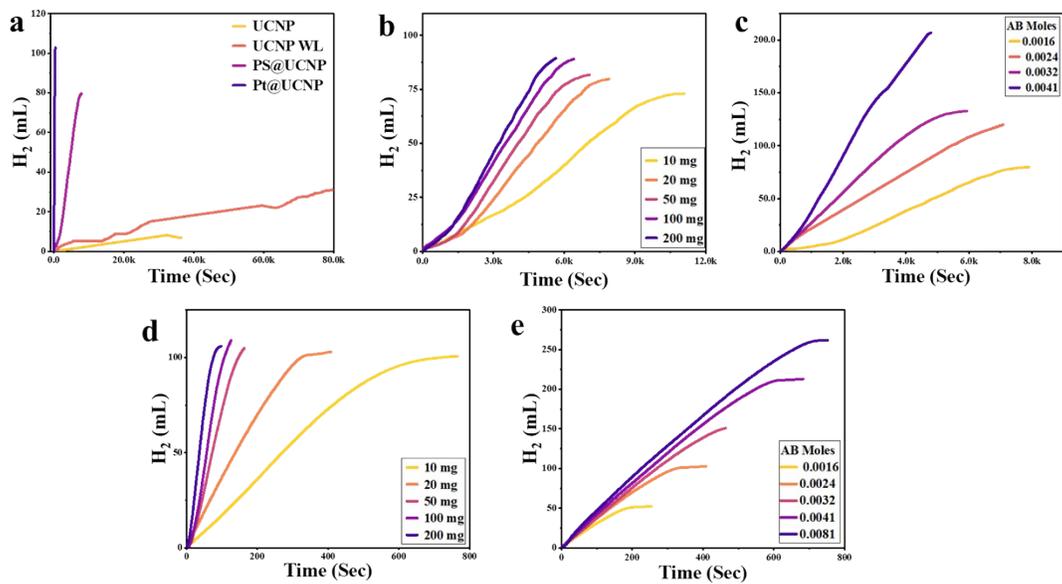


Figure S6: Photo-catalytic activity of PS@UCNPs and Pt@UCNPs. Hydrogen evolution rate of (a) UCNPs, PS@UCNPs, and Pt@UCNPs, (b) the effect of PS@UCNPs concentration, (c) the effect of AB concentration in the presence of PS@UCNP, (d) the effect of Pt@UCNPs amount, (e) the effect of AB concentration in the presence of Pt@UCNPs.

Table S2: ICP-OES results of the solid samples obtained by digestion. Data are given as average \pm SD (n=3).

Sample	Contents (Weight %)		
	Yb	Er	Pt
UCNPs	20.01 \pm 0.02	2.89 \pm 0.02	-
PS@UCNPs	19.97 \pm 0.01	2.86 \pm 0.01	-
Pt@UCNPs	19.98 \pm 0.02	2.85 \pm 0.01	1.90 \pm 0.01

Table S3: ICP-OES results of the solid samples obtained by digestion after five cycles. Data are given as average \pm SD (n=3).

Sample	Contents (Weight %)		
	Yb	Er	Pt
PS@UCNPs	18.26 \pm 0.02	1.95 \pm 0.01	-
Pt@UCNPs	14.50 \pm 0.01	0.95 \pm 0.01	1.75 \pm 0.03