

Supporting Information

Facile synthesis of Pd@Ru nanoplates with controlled thickness as efficient catalysts for hydrogen evolution reaction

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Table S1. ICP-AES data of the Pd@Ru bimetallic nanoplates with different thickness and the molar ratio of the Pd and Ru precursors fed in the synthesis.

Ru : Pd	molar ratio of the Ru and Pd precursors	atomic ratio of Ru/Pd
Pd@Ru (1.6)	26.4 : 73.6	25.1 : 74.9
Pd@Ru (1.9)	41.7 : 58.3	35.7 : 64.3
Pd@Ru (2.3)	51.8 : 48.2	49.4 : 50.6
Pd@Ru (2.6)	58.9 : 41.1	59 : 41

Table S2. Tafel slopes of the Pd@Ru nanoplate electrocatalysts with different thickness.

catalyst	Pd@Ru (1.6)	Pd@Ru (1.9)	Pd@Ru (2.3)	Pd@Ru (2.6)	Ru/C	Pt/C	Pd/C
Tafel slope	77	46	36	83	85	37	131

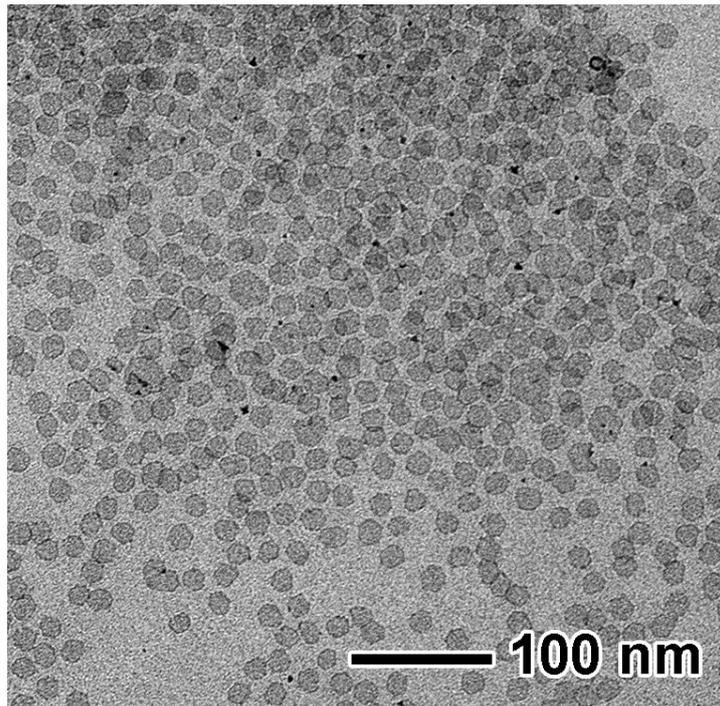


Figure S1. TEM image of Pd nanoplates with an average edge length of 6 nm.

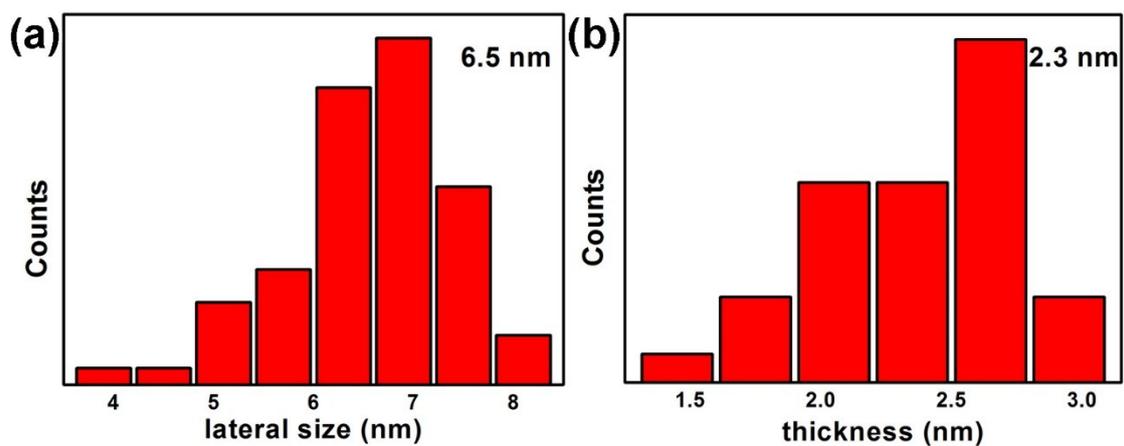


Figure S2. (a) The lateral size and (b) thickness distribution of the Pd@Ru nanoplates prepared using the standard procedure.

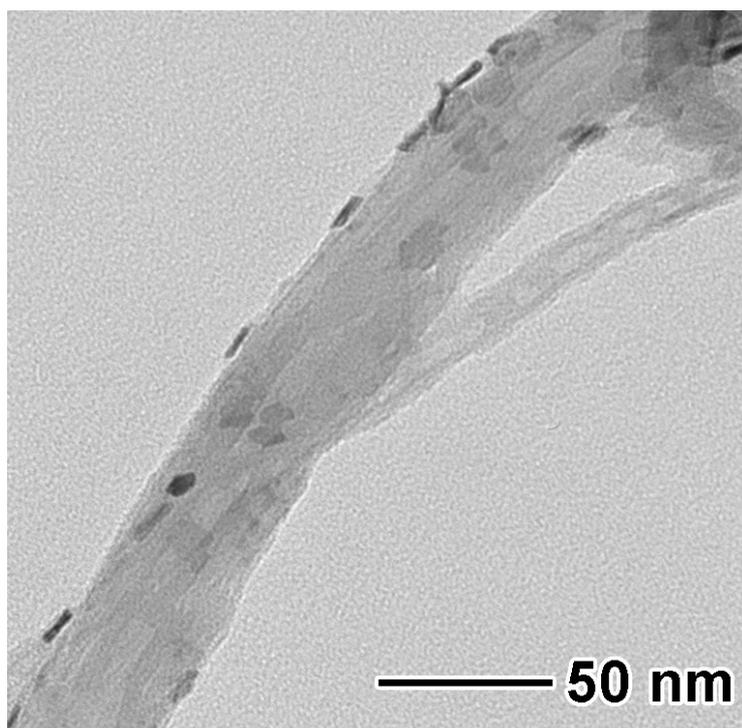


Figure S3. TEM images of the Pd@Ru nanoplates prepared using the standard procedure that mixed with the carbon nanotubes

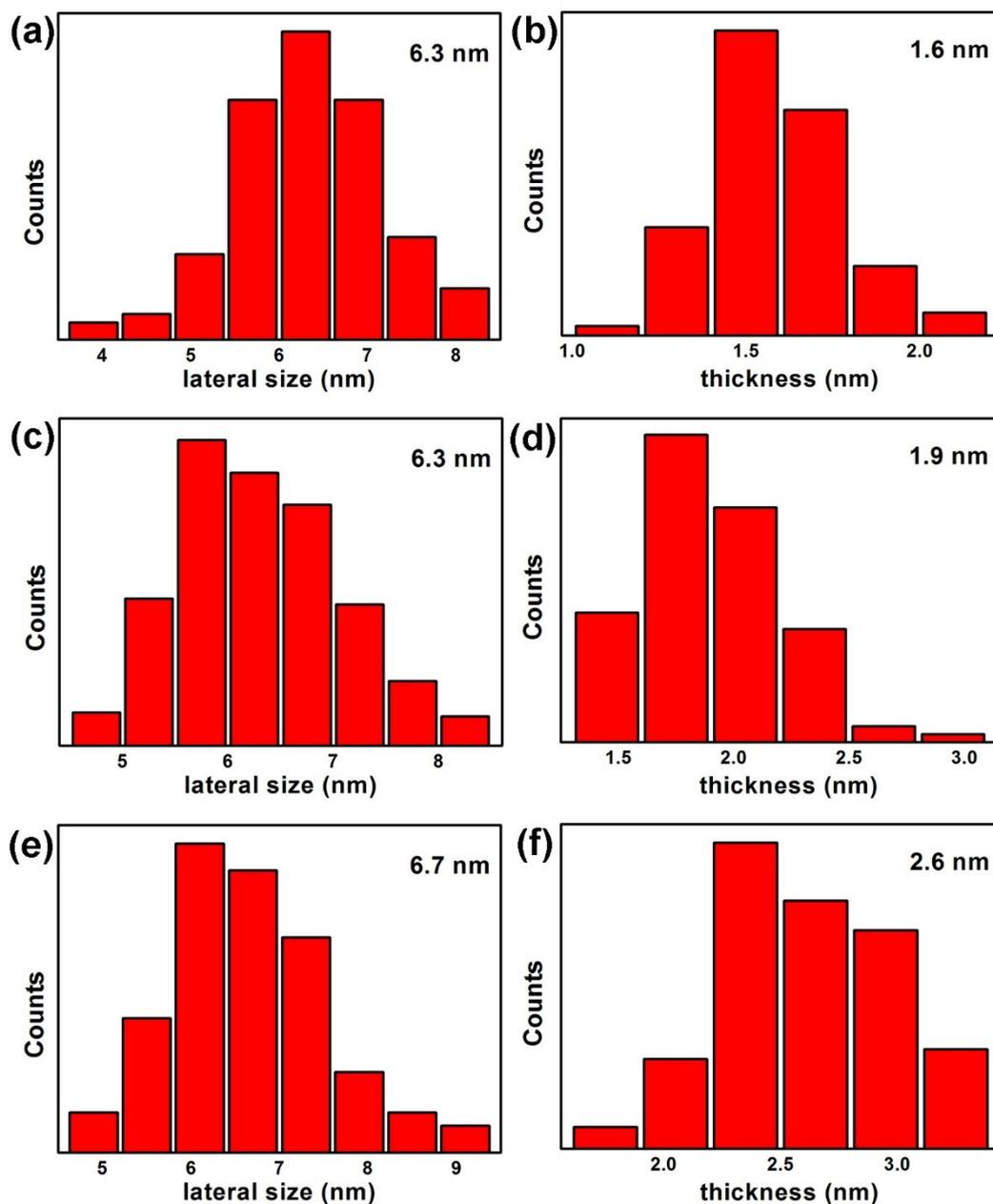


Figure S4. (a, c, e) The lateral size and (b, d, f) thickness distribution of the Pd@Ru nanoplates prepared using the standard procedure except with different amount of Ru precursor including 7.53, 15.06 and 30.12 μmol , respectively.

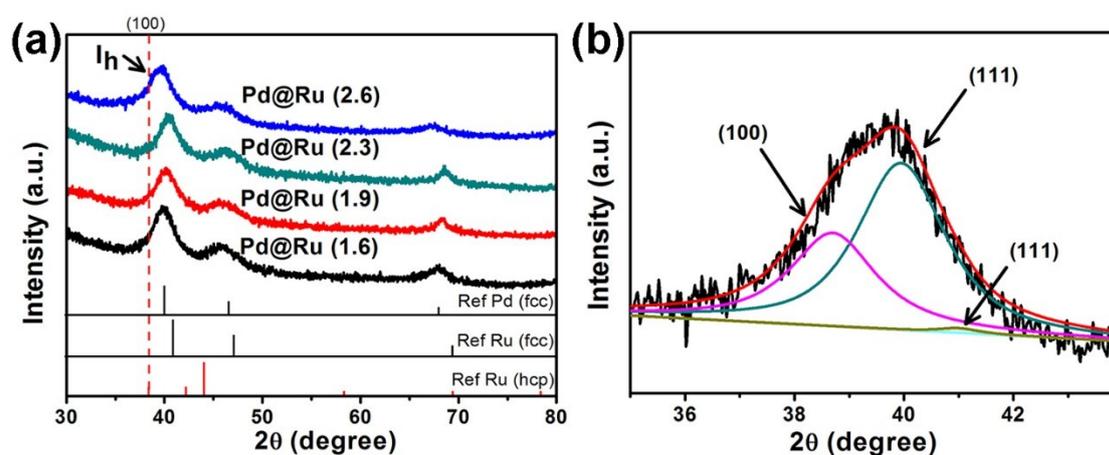


Figure S5. (a) XRD patterns of Pd@Ru nanoplates with different thickness: Pd@Ru (1.6), Pd@Ru (1.9), Pd@Ru (2.3) and Pd@Ru (2.6). (b) Enlargement of the XRD pattern of Pd@Ru (2.6) from 38° to 41°. Black bars in (a): JCPDS no. 65-6174 (*fcc* Pd) and JCPDS no. 88-2333 (*fcc* Ru), respectively. Red bars in (a): JCPDS no. 06-0663 (*hcp* Ru).

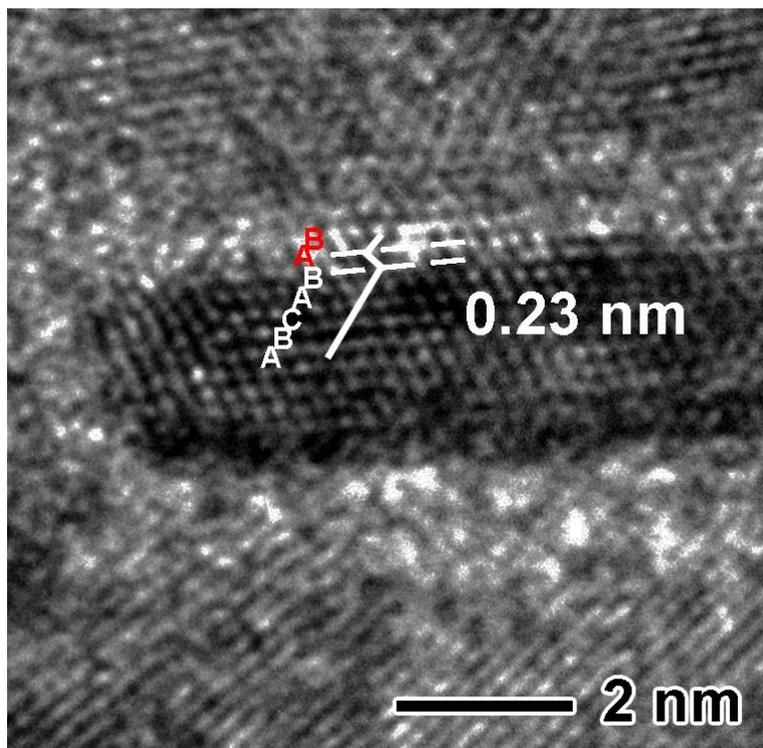


Figure S6. HRTEM image of an upright Pd@Ru (2.6) nanoplate.

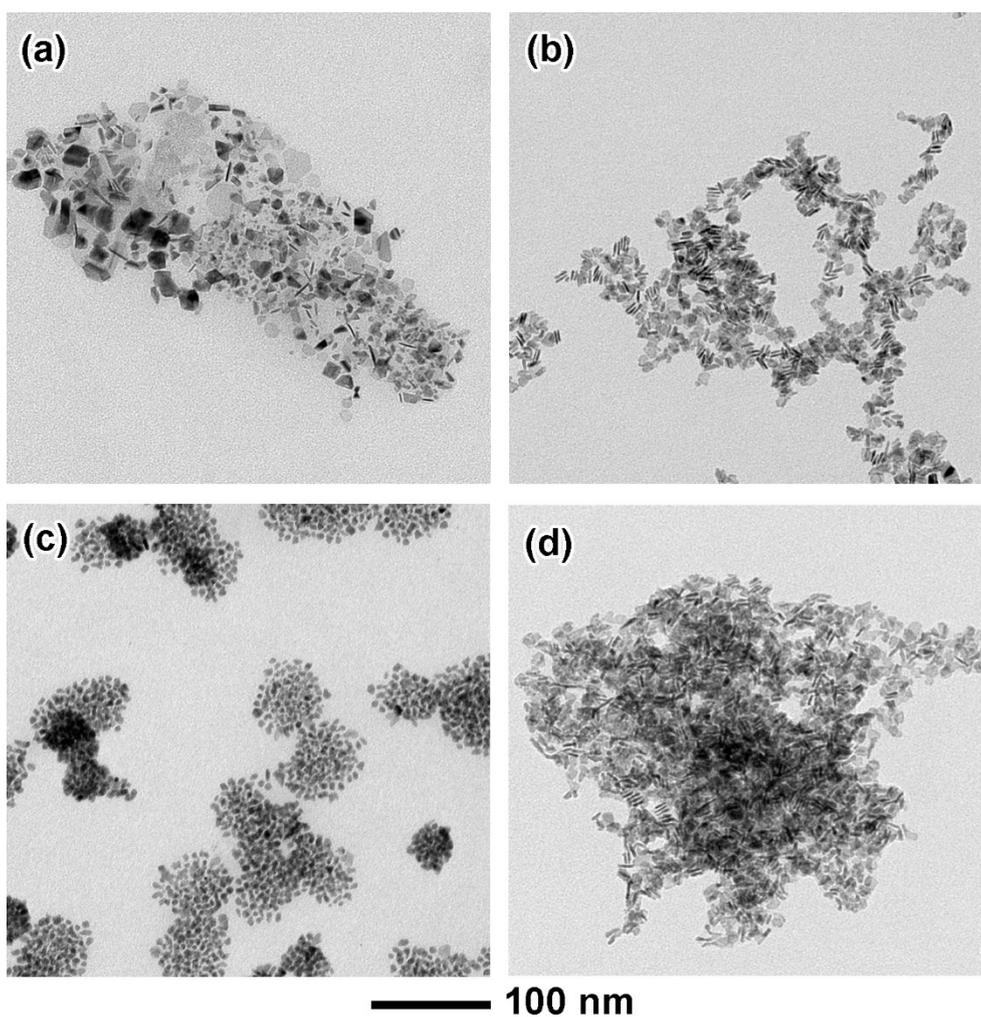


Figure S7. TEM images of the nanocrystals prepared using the standard procedure except (a) at a reaction temperature of 100 °C, (b) at a reaction temperature of 150 °C, (c) in the absence of Pd seeds, (d) without the introduction of any PVP.

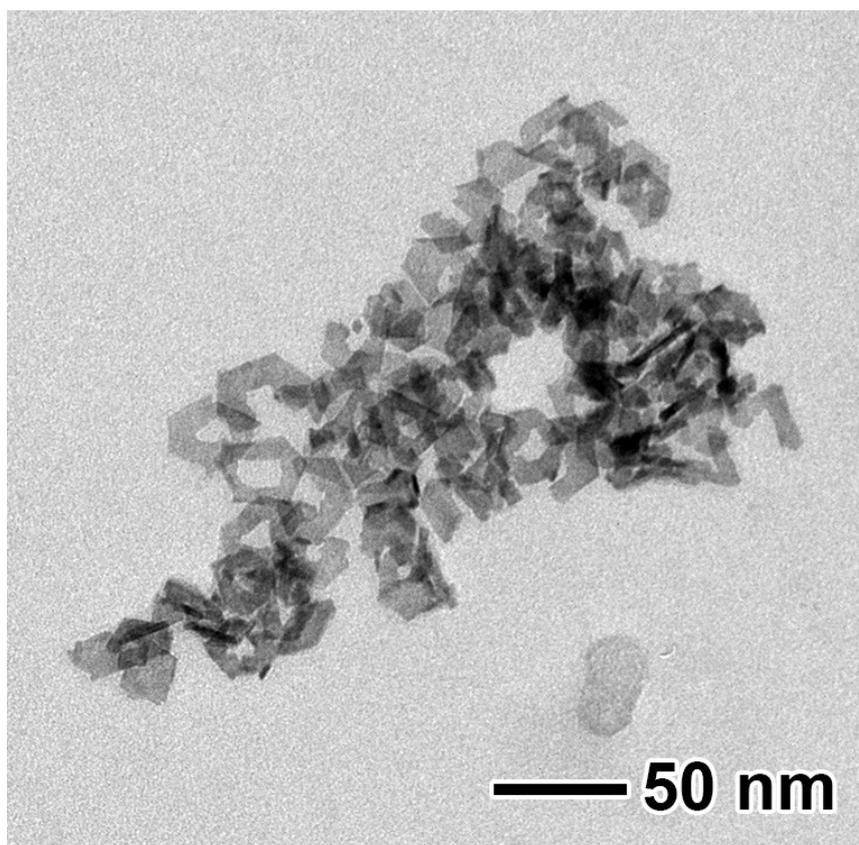


Figure S8. TEM image of the nanocrystals prepared using the standard procedure except in air condition.

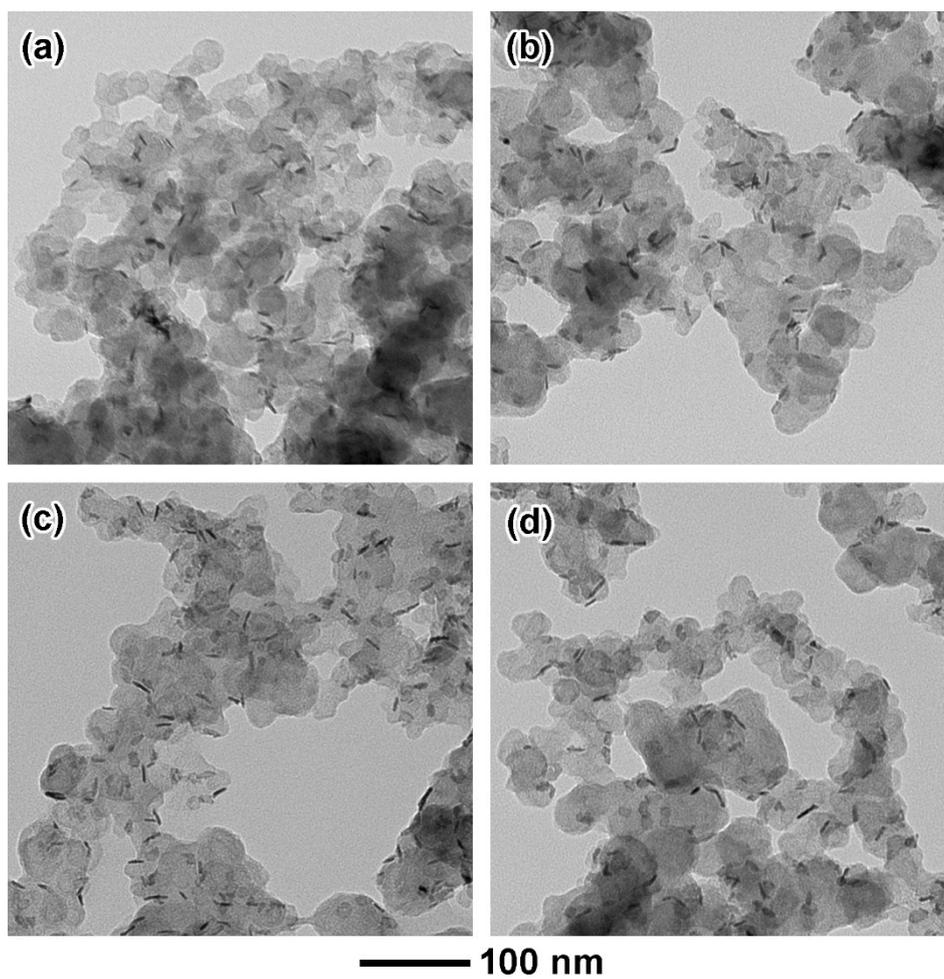


Figure S9. TEM images of (a) Pd@Ru (1.6), (b) Pd@Ru (1.9), (c) Pd@Ru (2.3) and (d) Pd@Ru (2.6) catalysts (20 wt% loaded on carbon).

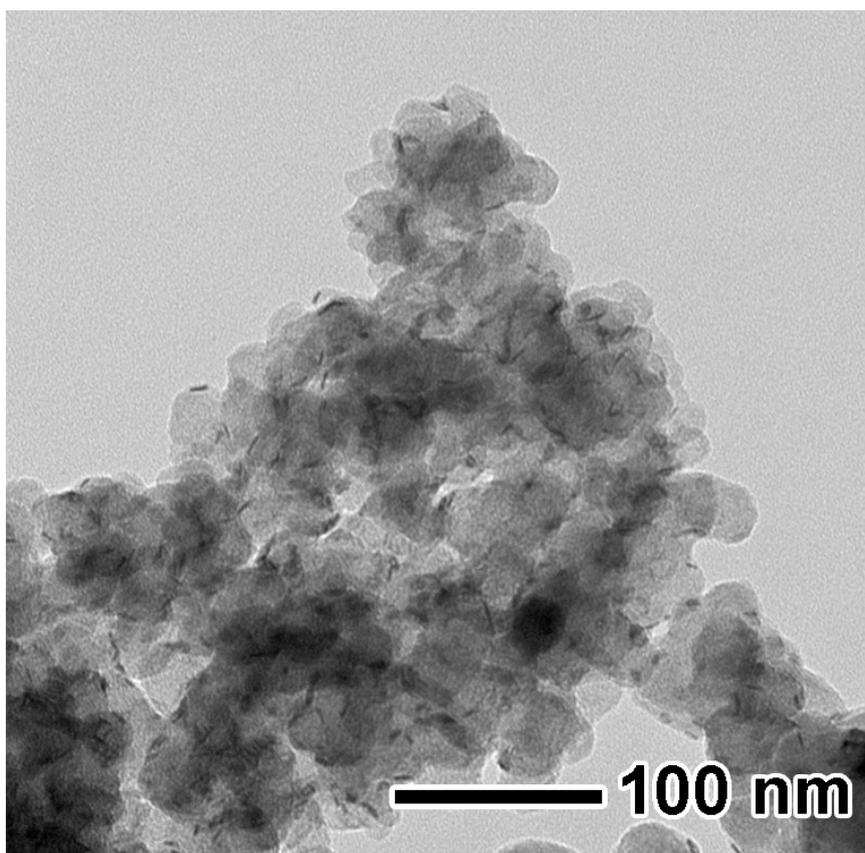


Figure S10. TEM image of Pd nanoplate (the same size as the Pd seeds) catalysts (20 wt% loaded on carbon).

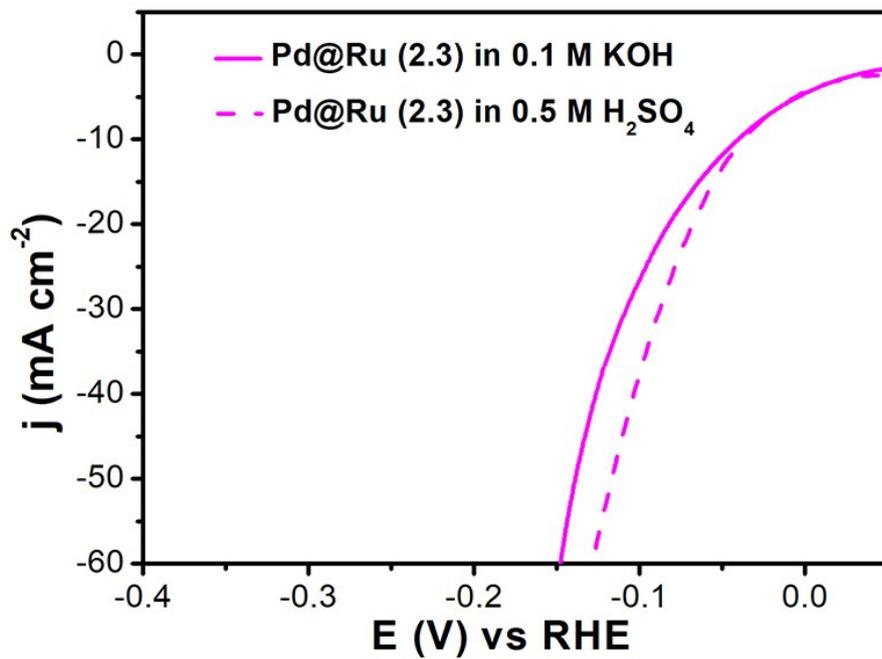


Figure S11. HER polarization curves of Pd@Ru (2.3) in 0.1 M KOH solutions and 0.5 M H_2SO_4 solutions.

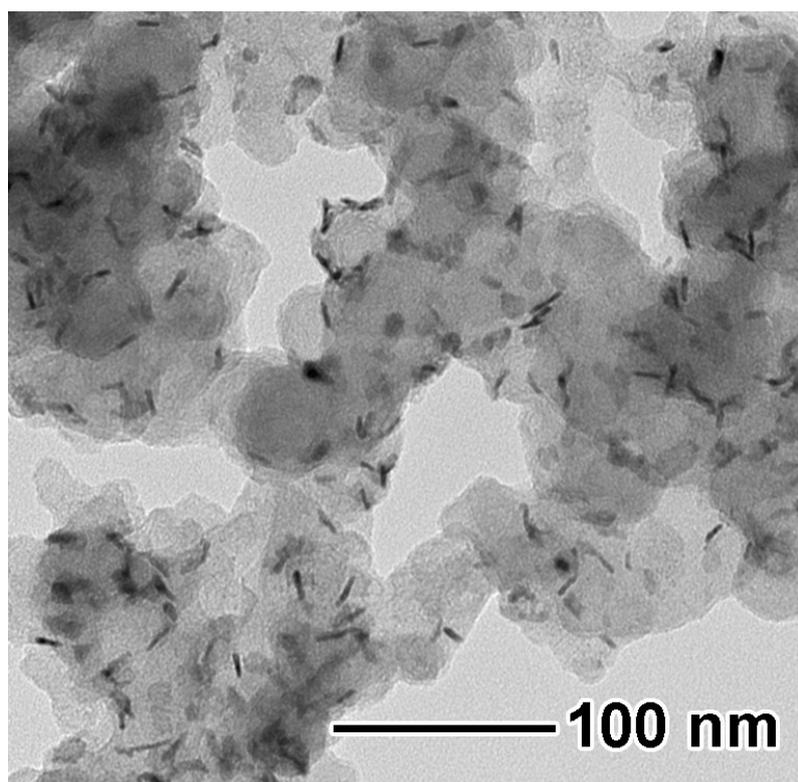


Figure S12. TEM image of Pd@Ru (2.3) catalysts after the chronoamperometric measurement.

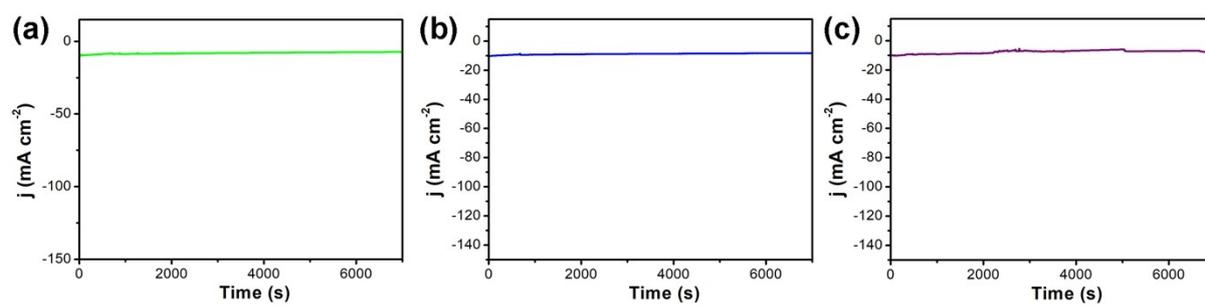


Figure S13. Current-time ($I-t$) chronoamperometric curves of (a) Pd@Ru (1.6), (b) Pd@Ru (1.9) and Pd@Ru (2.6) catalysts.