Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A

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Above 10% efficiency and one-week stability of Si photocathodes for water splitting by manipulating the loading of Pt catalyst and TiO_2 protective layer

Supporting Information

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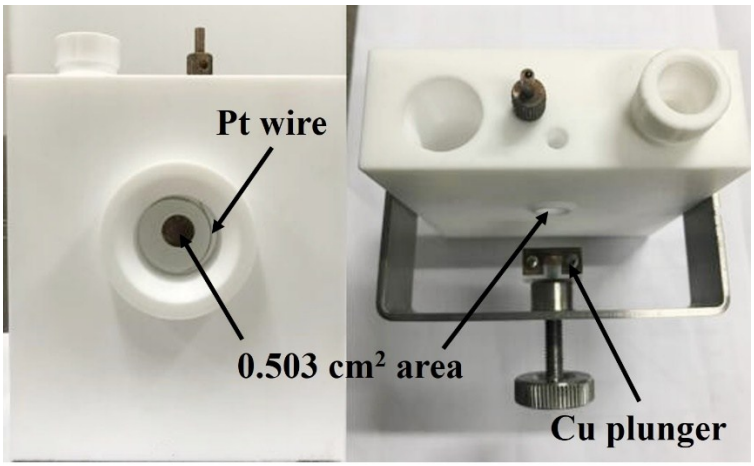

Figure S1. The photograph exhibition of custom-built Teflon electrochemical cell with a size of 96 mm×110 mm×32 mm. The backside of Si photocathode is contacted by a spring-loaded Cu plunger that also serves to press the working electrode against a Teflon gasket so that only the active area contacts the electrolyte. The active area of the Si photocathode is 0.503 cm^2.

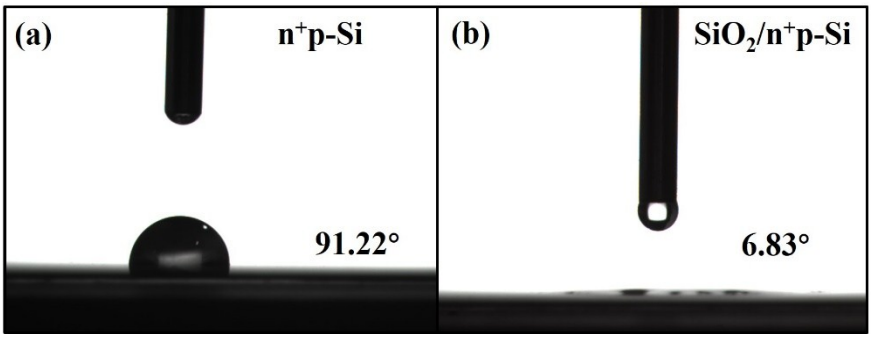

Figure S2. Water wettability of the n^+p-Si photocathodes (a) with and (b) without the native SiO_2 layer.

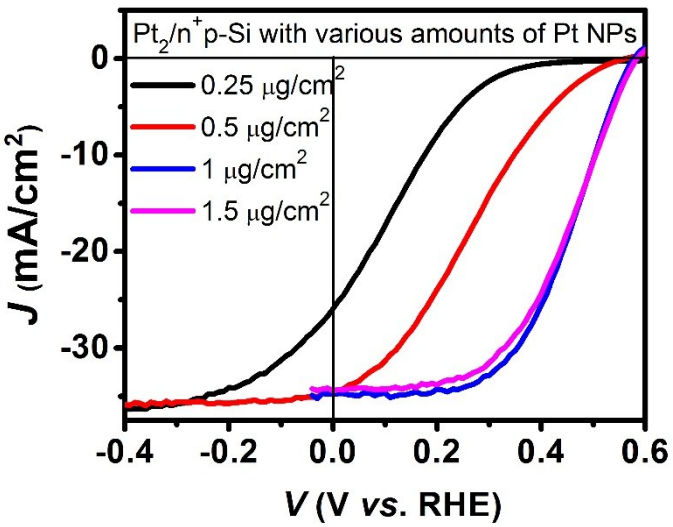

Figure S3. Consecutive LSV measurement for the $Pt_2/SiO_2/n^+p$-Si electrodes decorated with various amounts of Pt NPs.

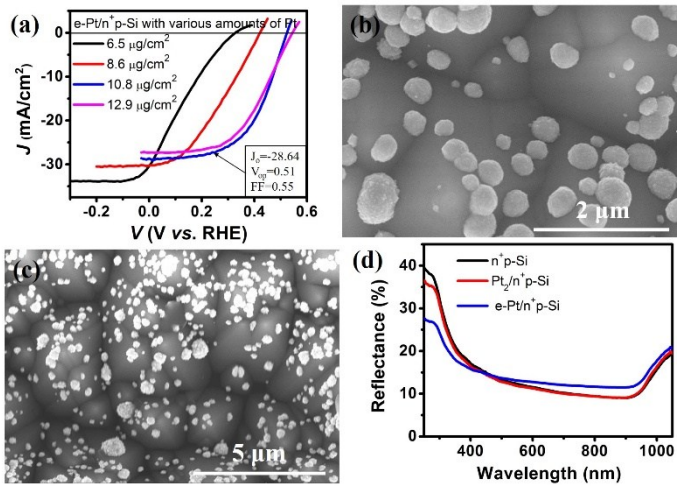

Figure S4. (a) Consecutive LSV measurements for the e-$Pt/SiO_2/n^+p$-Si electrodes decorated with various amounts of e-Pt particles. (b) High-magnification and (c) low-magnification top-down SEM images of the e-Pt/n^+p-Si. (d) Surface reflectance of bare n^+p-Si, Pt_2/n^+p-Si and e-Pt/n^+p-Si photocathodes.

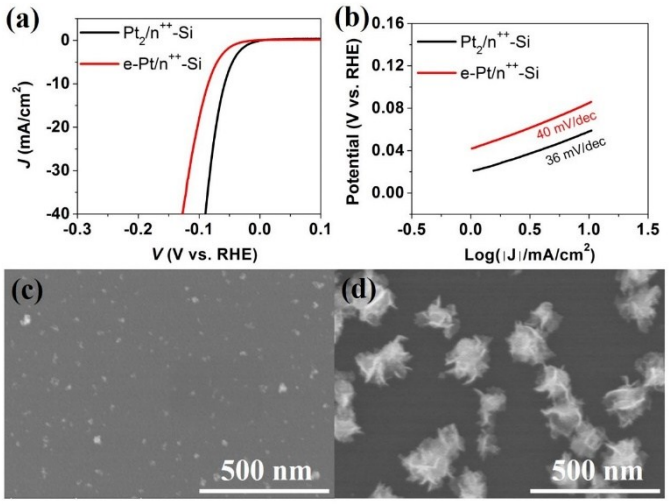

Figure S5. (a), (b) Electrocatalytic HER performance and corresponding Tafel plots of Pt NPs prepared by the electro- and electroless deposition, respectively. We used degenerately doped silicon wafer (n^{++}-Si) as the conductive substrates to replicate the same amount of Pt catalyst. Electrodes were then measured using a typical three electrode system in 1 M $HClO_4$ aqueous solution. (c), (d) The surface morphology of Pt NPs prepared by the electroless and electro- deposition on n^{++}-Si, respectively.

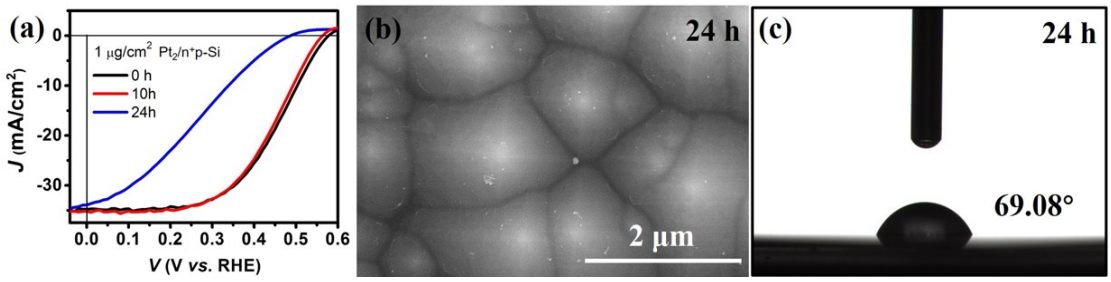

Figure S6. (a) Consecutive LSV measurements of Pt_2/n^+p-Si during the 10 and 24 h HER test. (b) Top-down SEM image and (c) water wettability of 1μg/cm^2 Pt_2/n^+p-Si after a 24 h PEC testing.

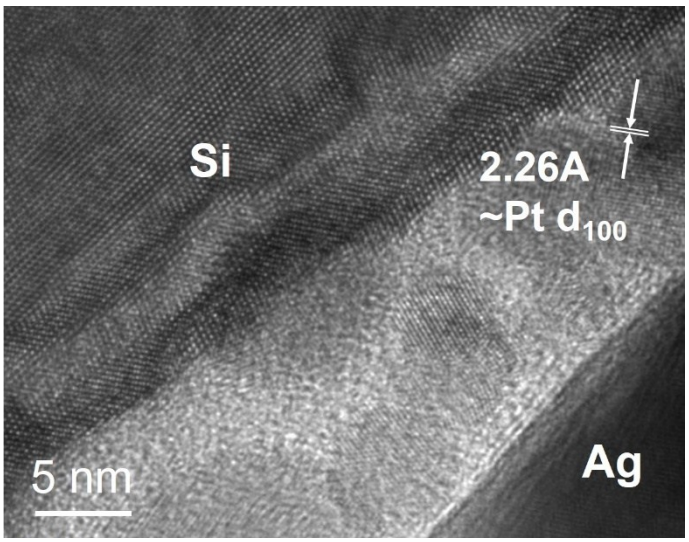

Figure S7. Cross-sectional HRTEM micrograph of Pt_2/n^+p-Si surrounded by TiO_2 layer.

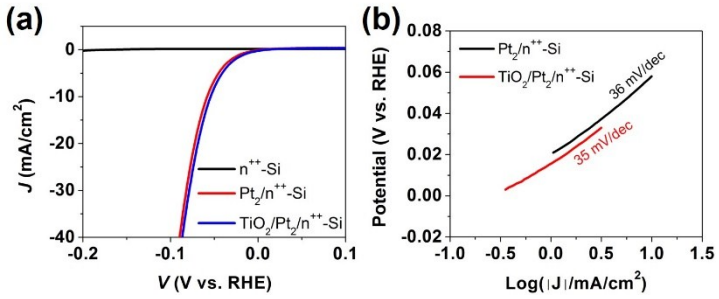

Figure S8. (a), (b) Electrocatalytic HER performance and corresponding Tafel plots of of Pt_2/n^{++}-Si with and without the decoration of TiO_2 layer.

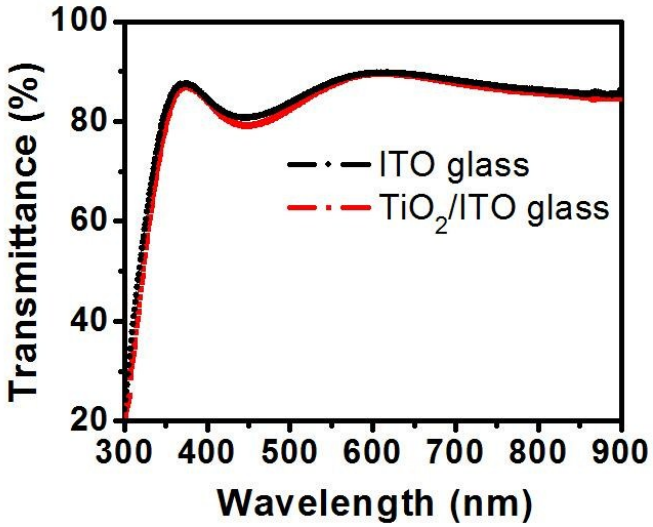

Figure S9. UV-Vis transmittance spectra of ITO glass substrates with and without the decoration of TiO_2 layer.

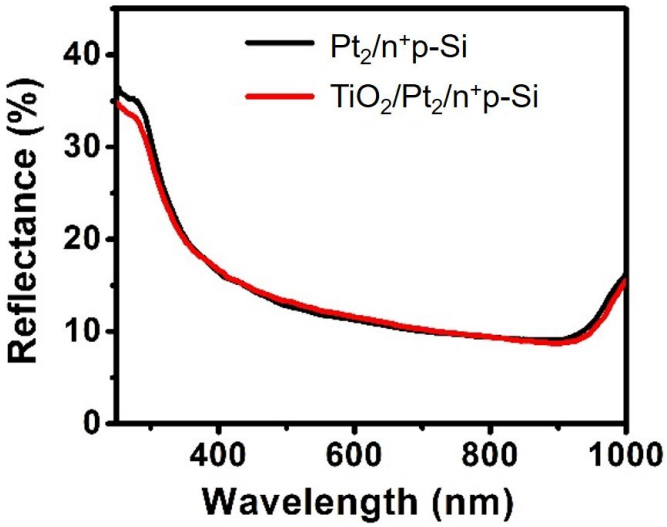

Figure S10. The reflection spectra of the Pt_2/n^+p-Si with and without the decoration of TiO_2 layer, measured using a Perkin Elmer Lambda 750 spectrophotometer in a wavelength range of 350−1000 nm, which uses BaSO4 as a reference. No significant difference is found between them.

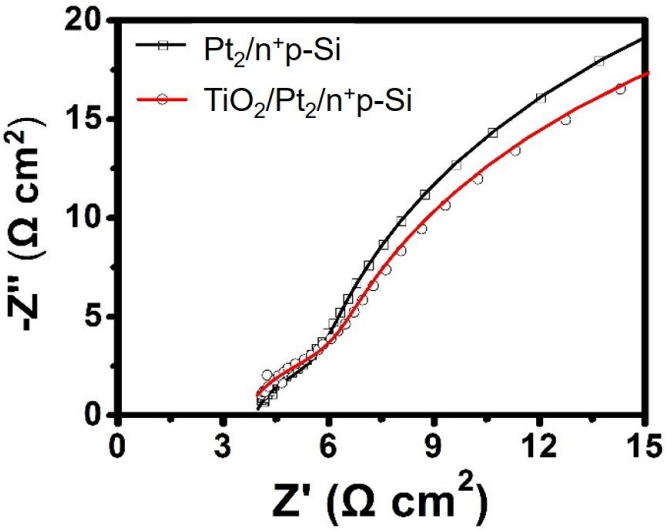

Figure S11. The enlarged photograph of Figure 5b.

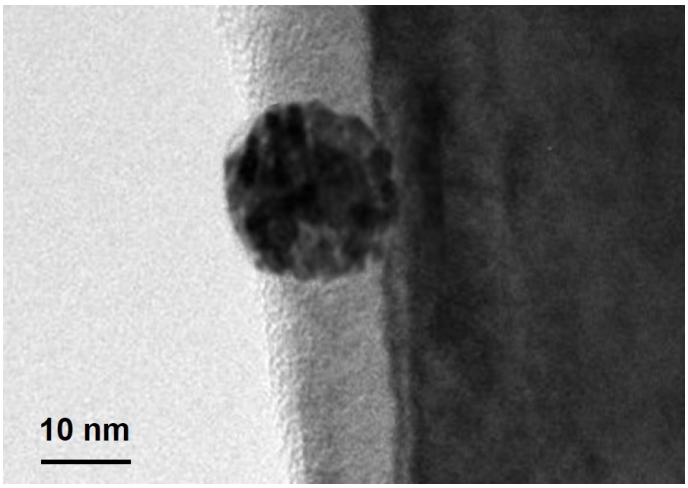

Figure S12. A representative cross-sectional HRTEM micrograph of $TiO_2/Pt_2/n^+p$-Si sample. The top surface of the Pt NPs with larger size than ~15 nm is not covered by TiO_2.

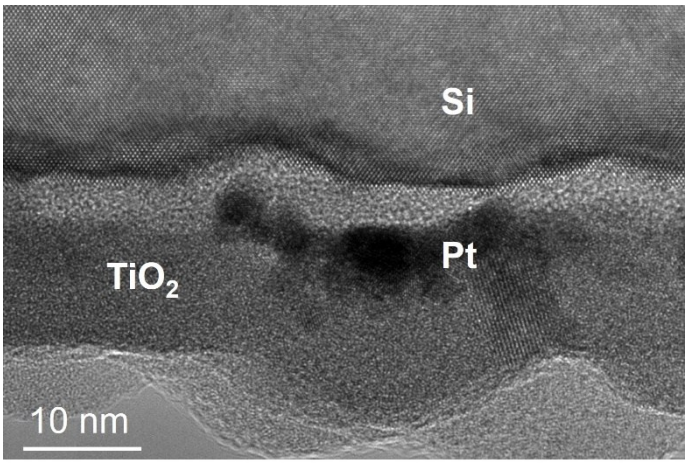

Figure S13. TEM measurement for the sample $TiO_2/Pt_2/n^+p$-Si after the 168-hour electrolysis.

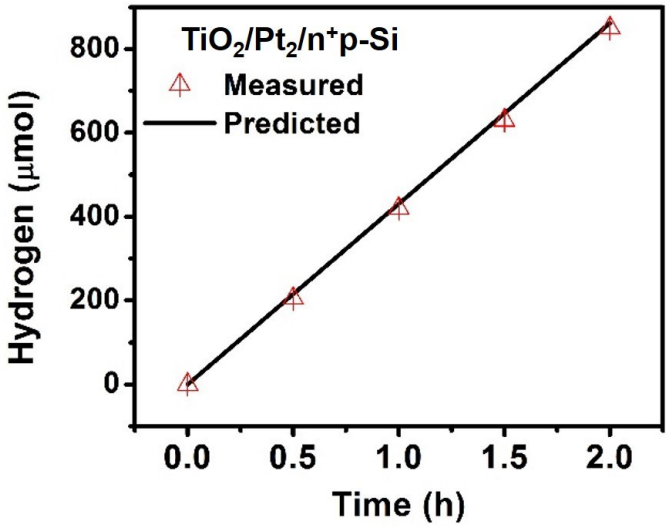

Figure S14. Theoretical calculated and measured H_2 amount measurements on $TiO_2/Pt_2/n^+p$-Si photocathode under simulated AM 1.5G illumination. These measurements show that this device evolves hydrogen with effectively 96% Faradaic efficiency within the experimental error.

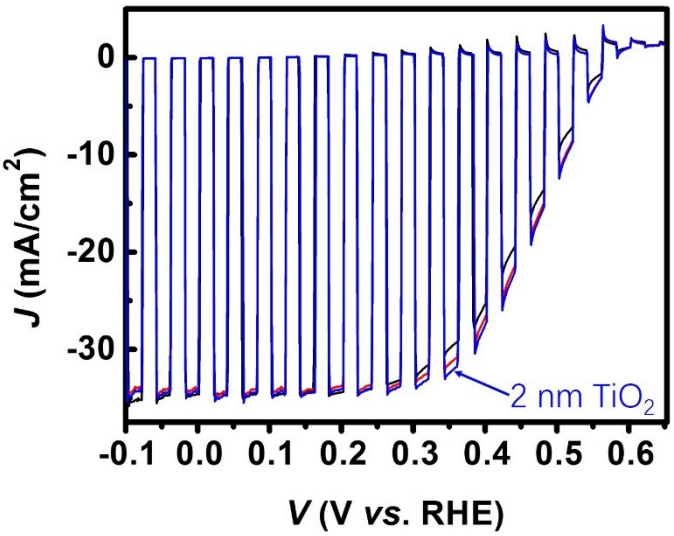

Figure S15. LSV curves under chopped illumination of Pt_2/n^+p-Si (black), 15 nm $TiO_2/Pt_2/n^+p$-Si (red) and 2 nm $TiO_2/Pt_2/n^+p$-Si (blue) photoelectrodes measured in 1 M $HClO_4$ solution under simulated AM 1.5G illumination.