Electronic Supplementary Material (ESI) for Energy & Environmental Science.

Supporting Information

A Quantitative Analysis of the Efficiency of Solar-Driven Water-Splitting Device Designs Based on Tandem Photoabsorbers Patterned with Islands of Metallic Electrocatalysts

Yikai Chen†[1], Ke Sun†[1,2],Heather Audesirk[2], Chengxiang Xiang[1] and Nathan S. Lewis[1-4*]*

1. *Joint Center for Artificial Photosynthesis, California Institute of Technology, Pasadena CA 91125, USA*

2. *Division of Chemistry and Chemical Engineering, 210 Noyes Laboratory, 127-72, California Institute of Technology, Pasadena, CA 91125, USA.*

3. *Beckman Institute and Molecular Materials Research Center, California Institute of Technology, Pasadena, CA 91125, USA.*

4. *Kavli Nanoscience Institute, California Institute of Technology, Pasadena, CA 91125, USA.*

†These authors contributed equally

*To whom correspondence should be addressed: nslewis@caltech.edu and cxx@caltech.edu

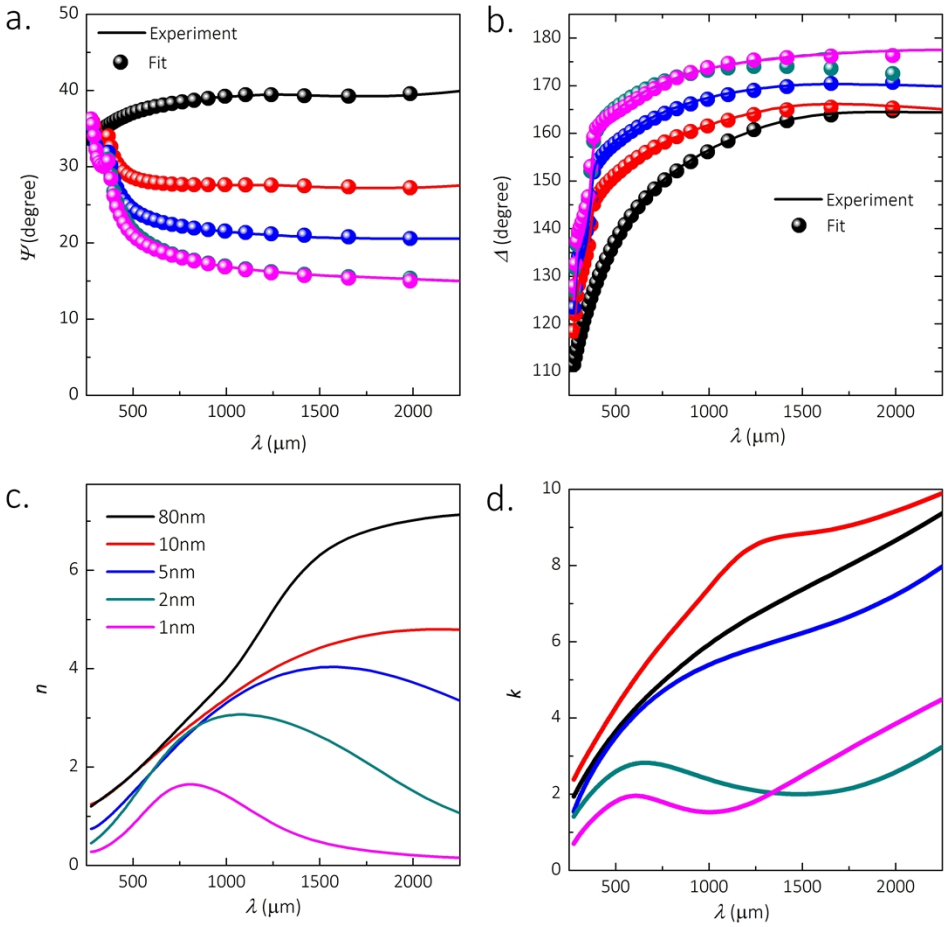

Figure S1. Representative ellipsometric data (curves) and fits (circles) showing the change in polarization as light reflects from Pt films coated crystalline Si substrates including the amplitude ratio, Ψ (a) and the phase difference, Δ (b) vs. wavelength at a

fixed incident angle of 65 degrees. Refractive indices (c) and extinction coefficients (d) of Pt films as a function of thickness.

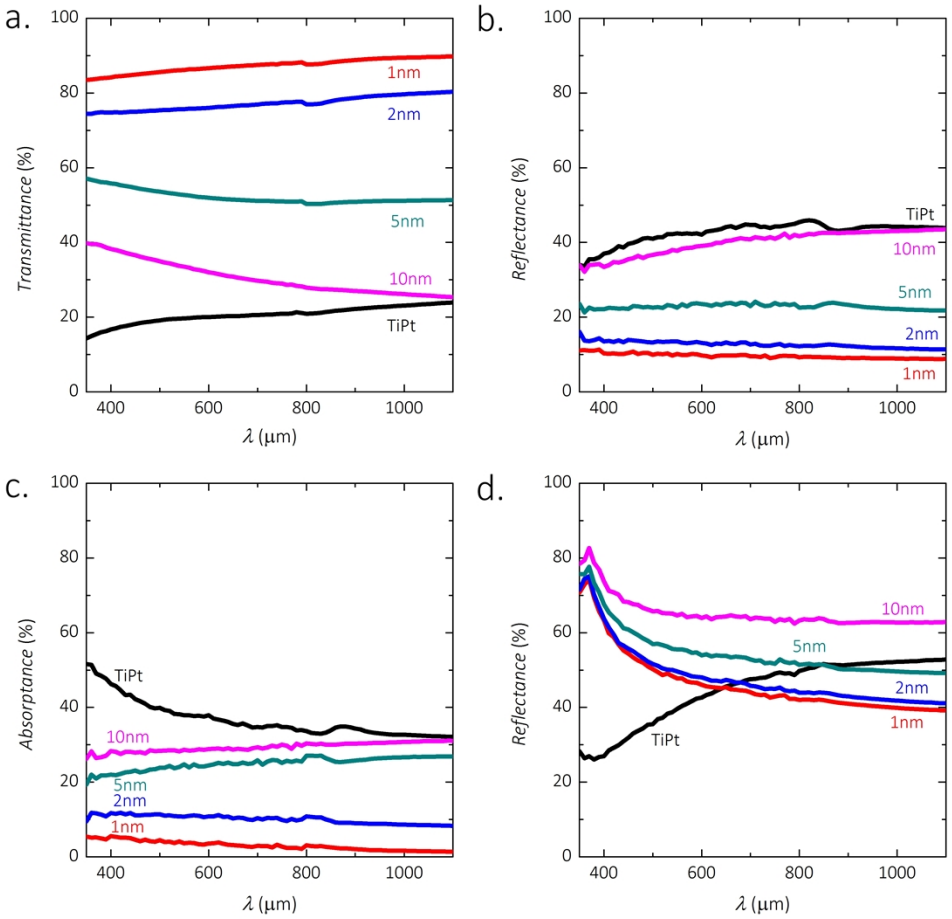

Figure S2. Transmittance, reflectance and absorbance of Pt films with various thicknesses coated on quartz substrates (a-c) and reflectance of Pt film-coated Si substrates (d). A 2-nm Pt coated crystalline Si with a 20 nm-Ti adhesion layer was also included for comparison.

Experimental current-density versus voltage relations for the photoabsorbers

To evaluate the solar-to-hydrogen (STH) conversion efficiency as a function of the filling fraction of the patterned catalyst films for fixed current-voltage relations of photoabsorber systems, current-voltage relations from a triple-junction amorphous hydrogenated Si (*a*-Si:H) cell (Xunlight, Inc.) and a triple-junction III-V cell (Spectrolab, Inc) were measured experimentally[1, 2].

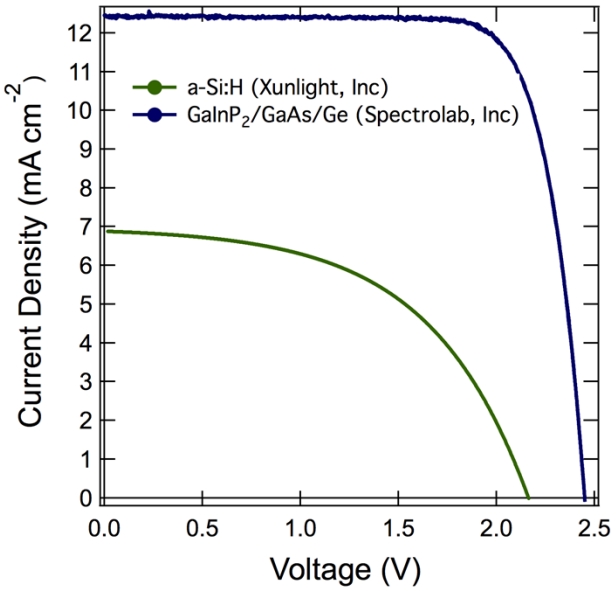

Figure S3. Current density as a function of applied voltage for a triple-junction amorphous hydrogenated Si (*a*-Si:H) (green) and a triple junction $GaInP_2$/GaAs/Ge cell (blue).

Estimation of the Cost of Pt

The cost of Pt per unit area as a function of its filling fraction is:

$$\frac{\$}{m^2} = 39.72 \cdot t \cdot \rho \cdot f_c \cdot 10^4$$

where 39.72 is the price of Pt in U.S. dollars/gram, t is the film thickness in cm, ρ is the bulk Pt density in g cm^{-3}, and f_c is the filling fraction.

1. K. Beernink, S. Guha, J. Yang, A. Banerjee, K. Lord, G. DeMaggio, F. Liu, G. Pietka, T. Johnson, M. Reinhout, K. Younan and D. Wolf, Lightweight, Flexible Solar Cells on Stainless Steel Foil and Polymer for Space and Stratospheric Applications, Brook Park, Ohio, 2005.
2. H. Cotal, C. Fetzer, J. Boisvert, G. Kinsey, R. King, P. Hebert, H. Yoon and N. Karam, *Energy Environ. Sci.*, 2009, **2**, 174-192.