Supporting Information for

Enhanced Flux of Chemically-Induced Hot Electrons on Pt Nanowire/Si Nanodiode during Decomposition of Hydrogen Peroxide

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Fabrication Method for the Pt Nanowire/Si Catalytic Nanodiode

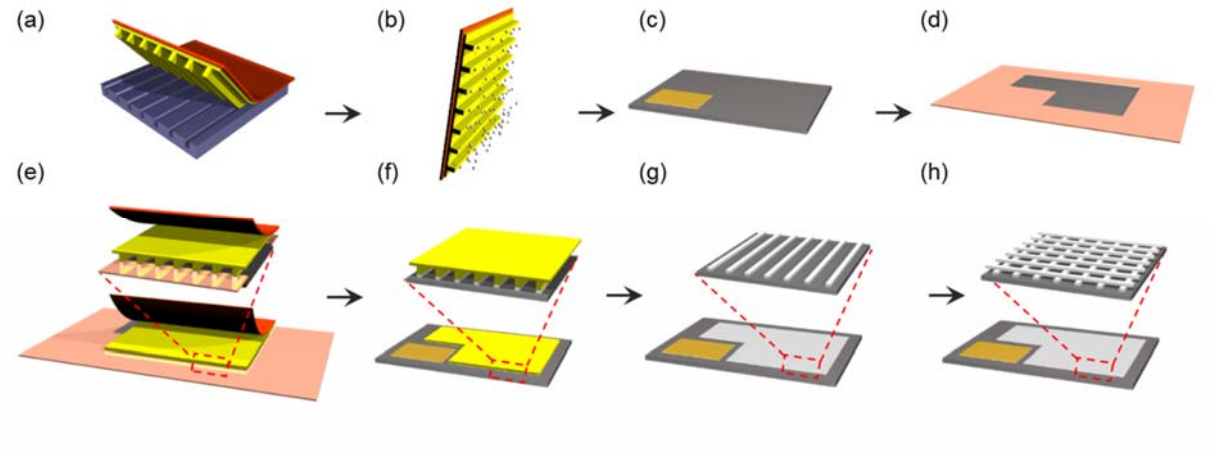

Figure S1. Fabrication process for solvent-assisted nanotransfer printing (S-nTP). (a, b) Preparation of highly ordered nanowire array. (c, d) Preparation of substrate. (e–h) Transfer printing of nanowire to the silicon substrate and eliminate polymer replica by washing with a solvent.

For Pt nanowires (NW)/n-Si, the same Au/Ti ohmic contact was deposited on the oxide-free Si substrate, and the as-prepared NWs were imprinted on the Si wafer. The Pt nanowires were fabricated using the solvent-assisted nanotransfer printing (S-nTP) method. The Si master templates for the line and space patterns were prepared using KrF photolithography and replicated by spin-coating polymethylmethacrylate (PMMA). The PMMA replicas were then lifted from the Si template using a polyimide (PI) adhesive film (Figure S1a). On the polymer replica, Pt was deposited using the electron-beam evaporation method to form highly ordered discrete nanowires (Figure S1b). The HF-cleaned Si substrate was prepared (Figure S1c) and covered by a Cu foil shadow mask with an open hole (Figure S1d). The Pt nanowires on the PMMA replica/PI were

selectively transfer-printed (Figure S1e). After removing the Cu foil mask and the adhesive film (Figure S1f), the polymer replica was subsequently washed with toluene (Figure S1g). To provide extensive electrical conductivity over the entire sample area, a second layer of nanowire arrays was printed perpendicular to the underlying layer by repeating the process in Figure S1. The apparent surface area of the Pt NW/n-Si exposed to the H_2O_2 solution was 0.8 cm^2. The prepared Pt/n-Si nanodiodes were stored in a desiccator.

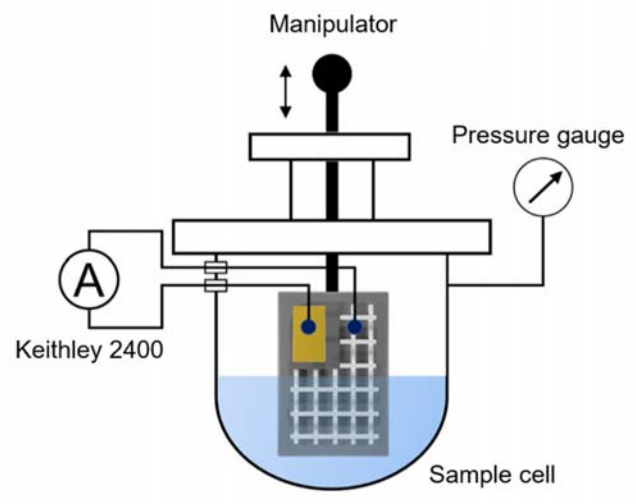

Figure S2. Schematic diagram of liquid-solid catalytic reactor. Chemicurrent and pressure were measured during hydrogen peroxide decomposition reaction.

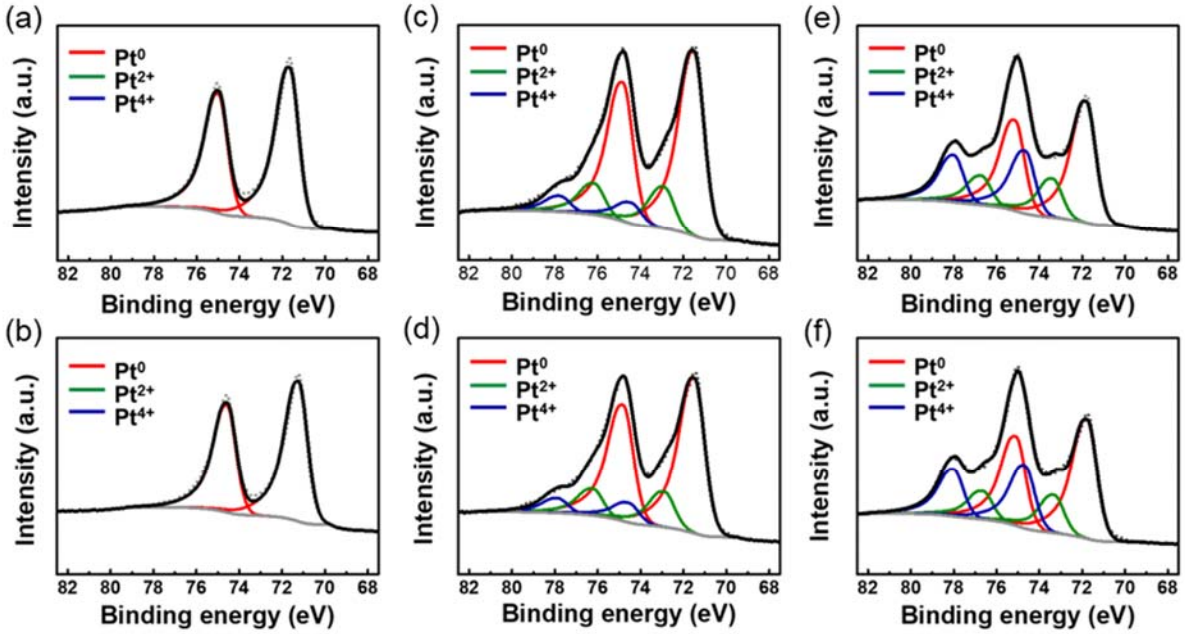

Figure S3. XPS analysis of (a, b) Pt film, (c, d) Pt NW and (e, f) Pt film with plasma treatment before and after reaction.

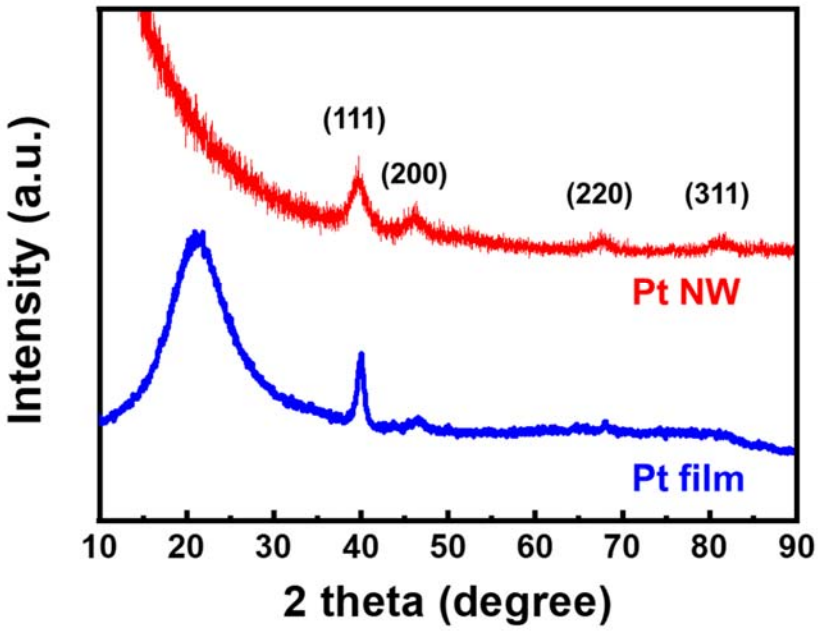

Figure S4. X-ray diffraction (XRD) patterns for Pt film and Pt NW.

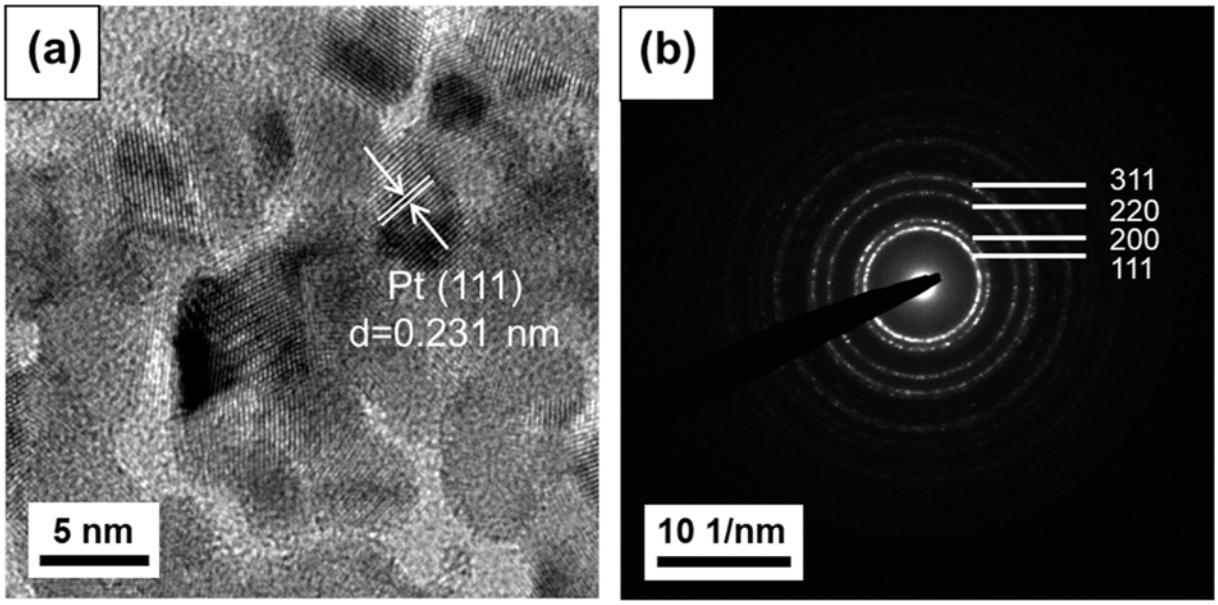

Figure S5. (a) HRTEM image of Pt NW imprinted on the Si wafer. (b) SAED pattern corresponding to (a). Unlike the Pt film in which (111) plane is dominant, Pt NW shows various crystalline structures of Pt (111), (200), (220) and (311).

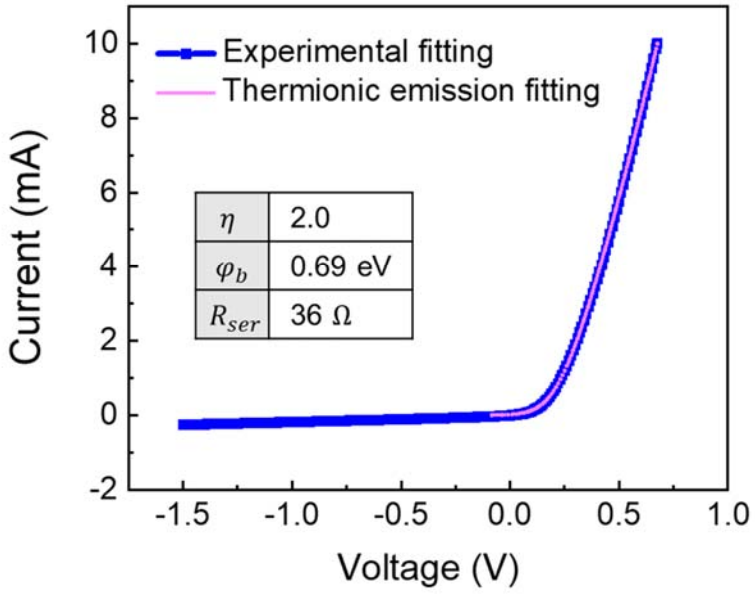

Figure S6. *I-V* curve of Pt film/n-Si under the light condition. The Schottky barrier height (φ_b) was 0.69 eV when the light is present, which is 0.05 eV smaller than the Schottky barrier height measured in the dark state.

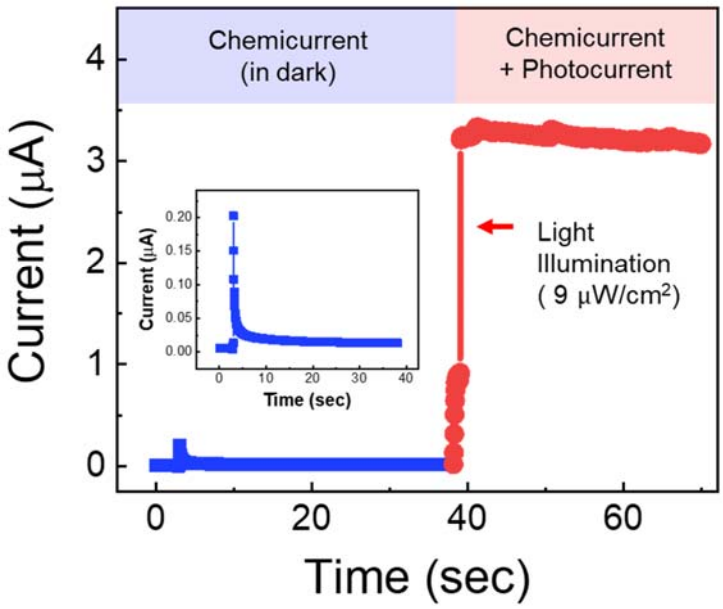

Figure S7. Measurement of chemicurrent of Pt film/Si during the H_2O_2 decomposition reaction in the presence of the light given by the halogen lamp with a light intensity of 9 μA/cm^2.

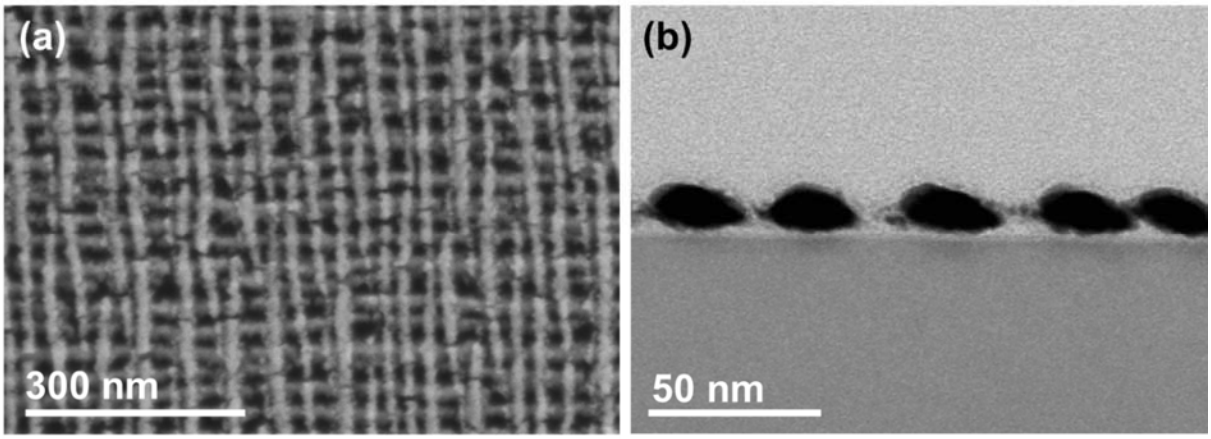

Figure S8. (a) SEM image and (b) TEM cross section image of the Pt NW* imprinted on the Si.

Figure S8 shows the SEM and TEM cross section image of Pt NW*/Si, which have a period of 30 nm, a width of 20 nm, while the original Pt NW has a period of 50 nm, a width of 25 nm. From Figure S8, the calculated contact area between Pt NW* and Si is 0.567 cm^2.

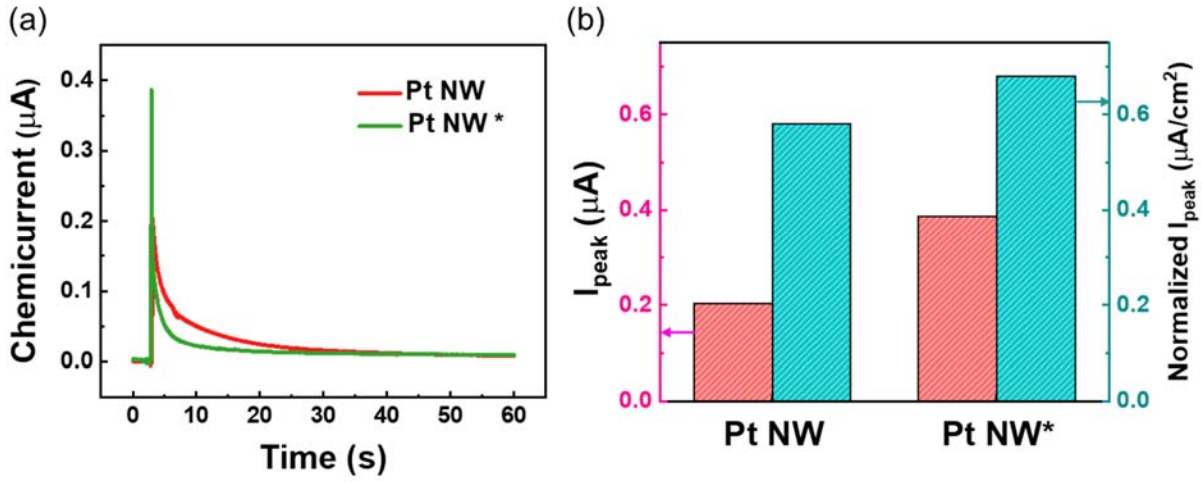

Figure S9. (a) Current signals of Pt NW/Si and Pt NW*/Si during H_2O_2 decomposition reaction. (b) Chemicurrent and normalized chemicurrent value of Pt NW/Si and Pt NW*/Si.

We measured the chemicurrent of the Pt NW*/Si with 5 wt% H_2O_2 solution in the dark liquid-solid reactor, which are the same experimental conditions as in the previous experiment. Apparently, Figure S9 (a) shows that Pt NW*/Si has a higher chemicurrent value (0.387 μA) than that of Pt NW/Si (0.203 μA). Also, Figure S9 (b) shows that the normalized chemicurrent value was increased in the Pt NW*/Si (0.68 μA/cm^2) than in the Pt NW/Si (0.58 μA/cm^2). Therefore, we can conclude that under the same detecting conditions, hot electron transfer improved as the edge of Pt/Si interface increased, because it led to shortening the hot electron travel length.

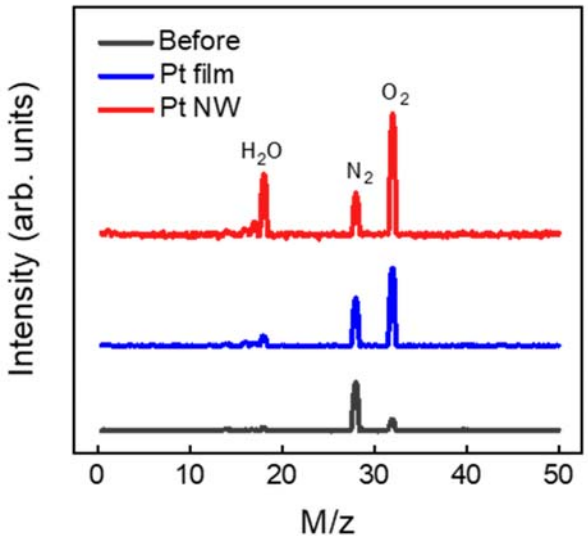

Figure S10. Mass spectrometer spectrum of the evolved gas on Pt/Si nanodiode during H_2O_2 decomposition reaction. The spectrum of before reaction is also shown. M/z=18, 28, 32 correspond to H_2O, N_2, and O_2, respectively.

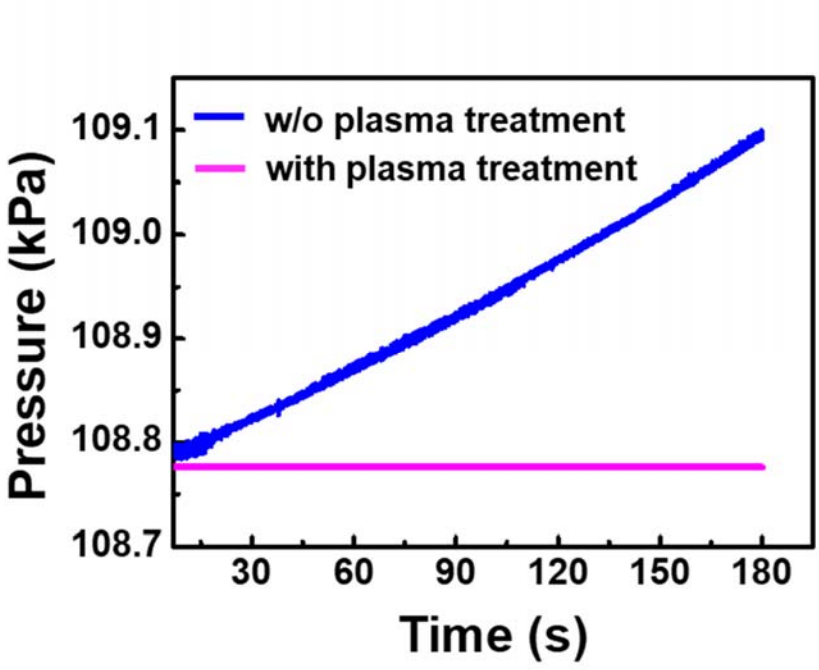

Figure S11. The effect of plasma treatment on Pt film. Pressure change over time of Pt film without (blue) and with (pink) plasma treatment during H_2O_2 decomposition reaction.

Movie S1 Pt NW.avi: Oxygen evolution on Pt NW/Si nanodiode

Movie S2 Pt film.avi: Oxygen evolution on Pt film/Si nanodiode

Movie S3 Pt film with plasma treatment.avi: Oxygen evolution on Pt film/Si nanodiode with plasma treatment