# Supporting information

# Light-induced Synthesis of Platinum/Titania Nanocapsules as An Efficient, Photosensitive and Stable Electrocatalyst

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## Experimental

For the RRDE or RDE experiments, the 50% Pt/$TiO_2$ NCs slurry was coated on a GC ring-disk electrode with 0.5 μg $mm^{-2}$, and the 50% Pt/C commercial catalyst was loaded with 0.5 μg $mm^{-2}$. In addition, the ring electrode with a fixed potential was set on 0.5 V with a rotating speed at 1600 rpm.

The transferred electron number (n) per oxygen molecule involved in ORR can be calculated by the currents measured from the ring and disk electrode in terms of the following equation:

$$n = \frac{4|i_d|}{|i_d| + i_r/N} \quad (1)$$

where N = 0.45, $i_d$ and $i_r$ are the collection efficiency, disk current and ring current, respectively.

The K-L plots has been calculated from the under K-L equation (2). The K–L plots show linear relationships between $J_k^{-1}$ and $\omega^{-1/2}$ for Fe-$N_x$-C900 catalyst.

$$J^{-1} = J_K^{-1} + J_L^{-1} = J_K^{-1} + B^{-1}\omega^{-1/2} \quad (2)$$

$$B = 0.62nFC_O(D_O)^{2/3}\,\nu^{-1/6} \quad (3)$$

$$J_K = nFkC_O \quad (4)$$

where $J$ is the measured current density; $J_L$ is the diffusion limit current density; $J_K$ is the dynamic current density; ω is the angular velocity of the disk (ω = 2πN, N is the linear rotation speed); n is the overall number of electrons transferred in oxygen reduction; F is the Faraday constant; $C_O$ is the bulk concentration of $O_2$; ν is the kinematic viscosity of the electrolyte, and k is the electron-transfer rate constant.

The electrochemical active surface area (ECSA) α ($cm^2\ mg^{-1}$) for a catalyst can be estimated from the following equation [43]:

$$\alpha = Q/(m\beta) \quad (5)$$

Where Q is the charge for hydrogen desorption ($C\ cm^{-2}$), m the quantity of Pt used (=0.4 $mg\ cm^{-2}$ in the present study), and β the charge required to oxidize a monolayer of $H_2$ on bright Pt (= $0.21x10^{-3}$ $C\ cm^{-2}$) [43]. Calculations based on the CV (Fig. 4a) show that the ECSA of the present catalyst is the highest without considering the contribution of the double-layer charge.

wt% of 50% Pt/$TiO_2$ NCs is 50 wt.%. We take 100 mg $TiO_2$ NCs as support and 265.6 mg chloroplatinic acid hexahydrate ($H_2PtCl_6 \cdot 6H_2O$), leading to mass ratio is 1:1; 198.2 mg 50% Pt/$TiO_2$ NCs are obtained after depositing Pt. Thus, Pt loading amount is 50 wt.%.

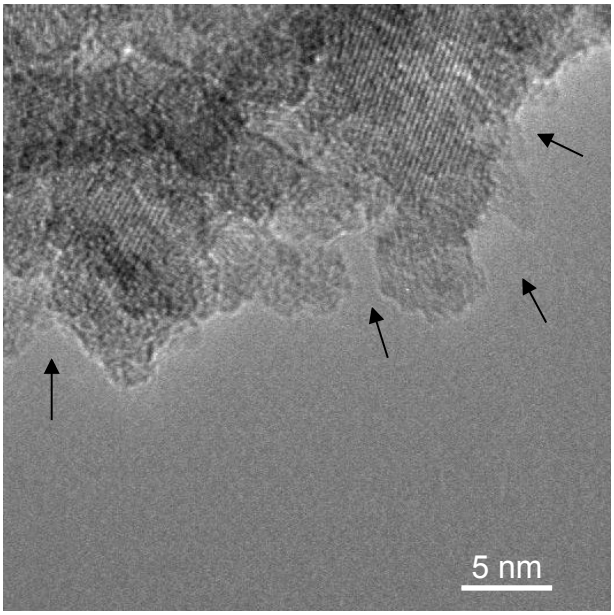


**Figure S1**. HRTEM image of 2-5 nm gases in $TiO_2$ NCs.

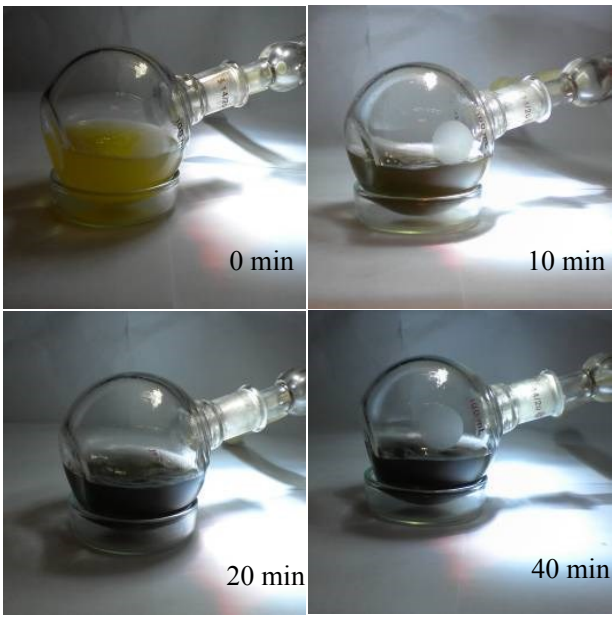


**Figure S2.** Images of UV light-induced synthesis of Pt /$TiO_2$ nanomaterials.

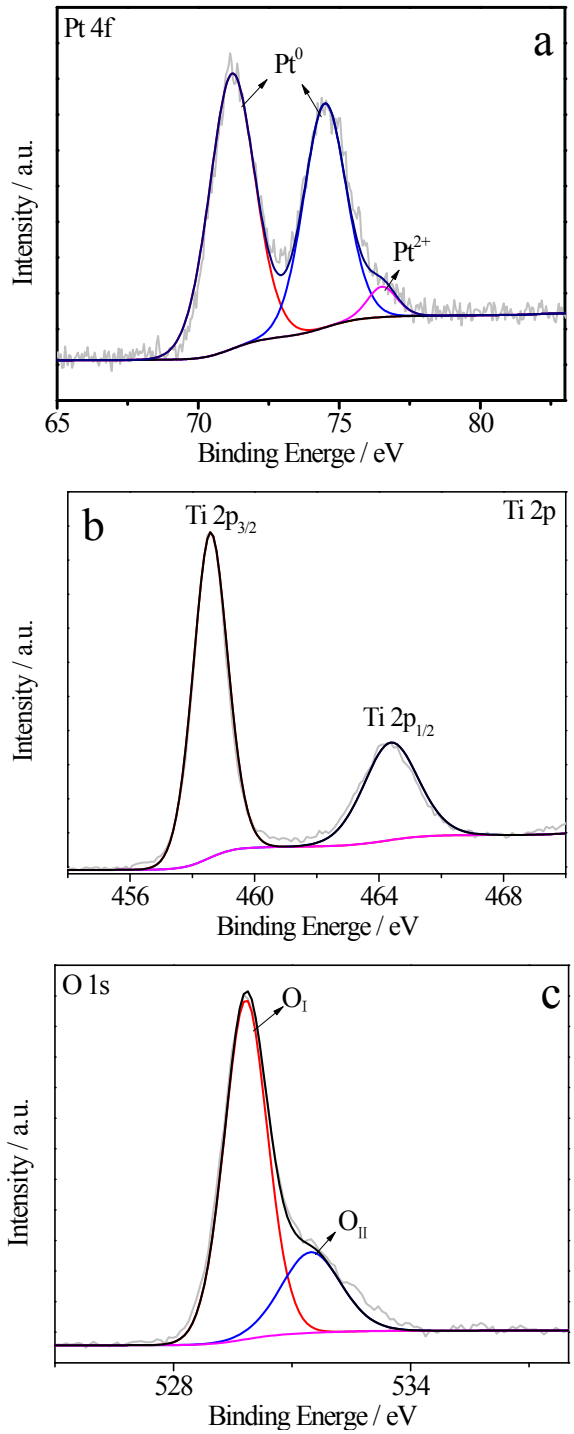


**Figure S3.** (a) Pt 4f, (b) Ti 2p and (c) O 1s spectra of 50% $Pt/TiO_2$ NCs.

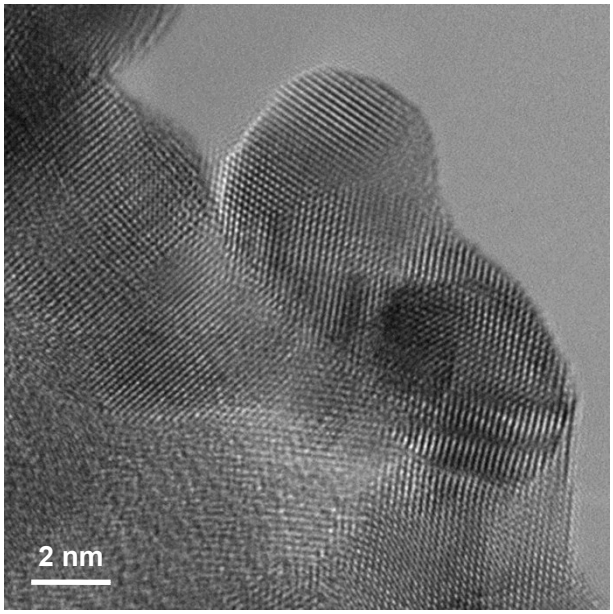


**Figure S4.** HRTEM image of 66.7% Pt/$TiO_2$ NCs.

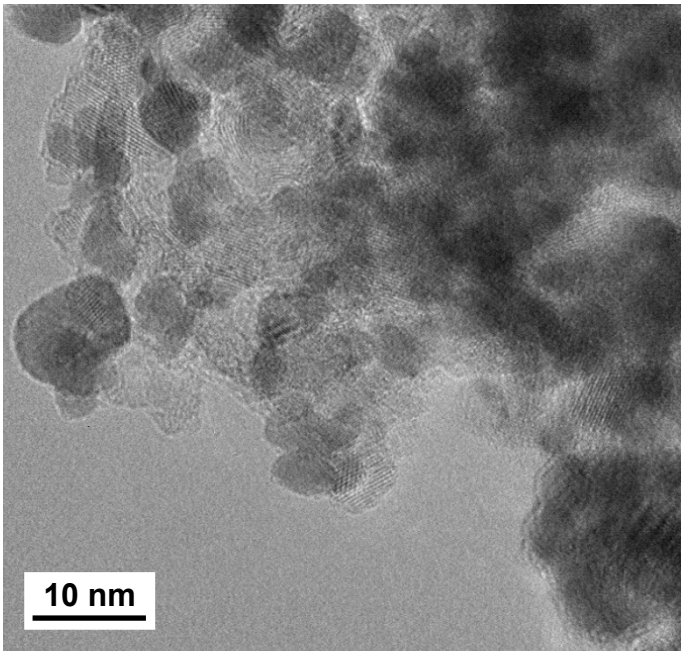


**Figure S5.** HRTEM image of 50% Pt/$TiO_2$ NCs after 2000 cycles.

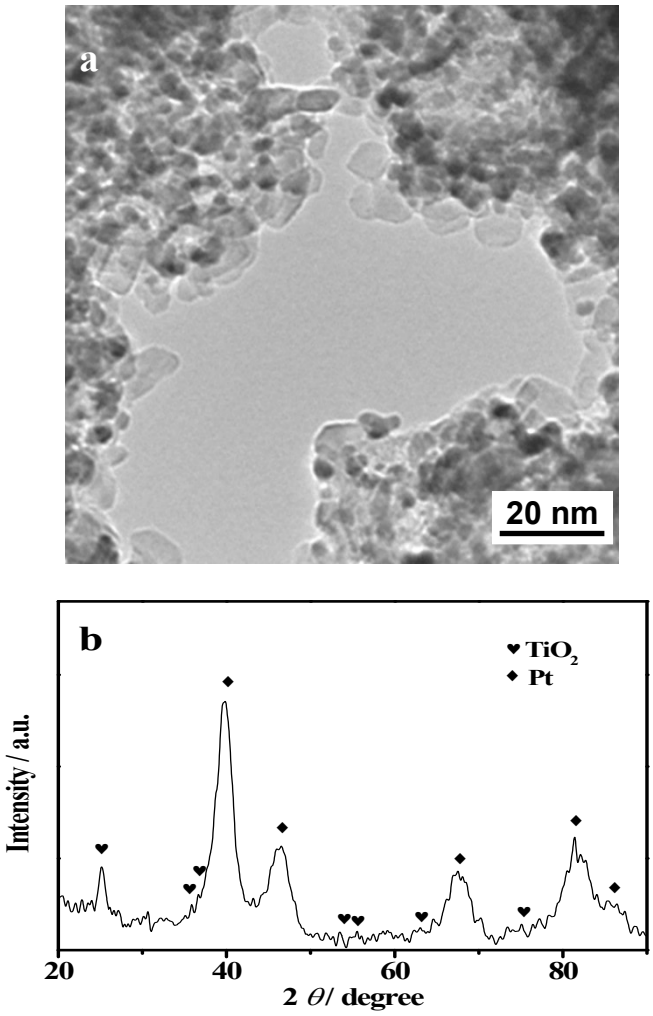


**Figure S6.** (a) TEM image and (b) XRD pattern of 20% $Pt/TiO_2$ NCs.

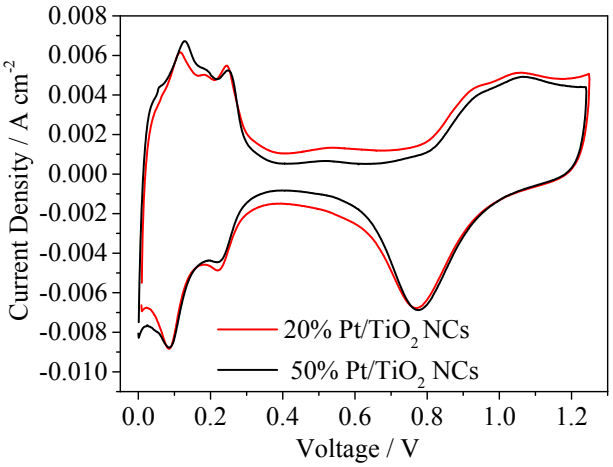


**Figure S7.** Cycle voltammetry measurements of 20% and 50% $Pt/TiO_2$ NCs.

**Table S1.** Electrochemical active surface areas (ECASA) of the catalysts calculated

from the cyclic voltammetry without the contribution of charges from the "double electric layer".

| Catalyst | 50% $Pt/TiO_2$ NCs | 20% $Pt/TiO_2$ NCs | 50% Pt/C (Commercial) | 66.7% Pt/TiO$_2$ NCs | 50% Pt/ commercial $TiO_2$ |
|---|---|---|---|---|---|
| $\alpha$ ($cm^2\ mg^{-1}$) | **805** | 720 | 589 | 705 | 315 |

**Table S2.** Characterization of catalysts.

| Catalyst | HER | ORR | |
|---|---|---|---|
| | Tafel slope (mV $dec^{-1}$) | half-wave potential (V) | $J_k^b$ (mA $cm^{-2}$) |
| 50% $Pt/TiO_2$ NCs (Dark) | 39 | 0.714 | 3.34 (0.7V) |
| 50% $Pt/TiO_2$ NCs (UV light) | 32 | 0.76 | 4.65 (0.7V) |
| Commercial 50% Pt/C | 41 | 0.703 | 3.02 (0.7V) |