Supporting information

Porous-structured of platinum nanocrystals supported on carbon nanotube

film with super catalytic activity and durability

Xin Xin Huang^{*a*,#}, Yun Chen^{*b*,#}, Xiao Xia Wang^{*a*}, Jian Nong Wang^{*a*,*}

^a Nano-X Research Center, School of Mechanical and Power Engineering, East China University of Science and Technology, 130 Meilong Road, Shanghai 200237, P. R. China. Tel: +86-21-64252360. E-mail: jnwang@ecust.edu.cn
^b School of Materials Science and Engineering, Shanghai Jiao Tong University, 800 Dong Chuan Road, Shanghai 200240, P. R. China.
[#] Co-first authors.





Figure S1. CNT film. (a) As-prepared film, (b) its SEM and (c) TEM images, (d) the film after purification, (e, f) potential cycling for Fe purification. Note the presence of a low content of Fe particles seen as dark dots before purification and their absence after purification. (f) is the enlarged rectangular region in (e). The Fe peak became negligible typically after 15 cycles. Scale bars, 1.5 cm (a), 500 nm (b), 200 μ m (c), and 1 μ m (d).



Figure S2. Schematic of the electrodeposition system (a) and TEM images of Pt crystals in the prepared catalyst of Pt/CNTF-1 (b, c).



Figure S3. Typical TGA curve. Pt content was about 45 wt.%, and the Pt loading on RDE was calculated to be 90 μ g cm⁻², which was close to that measured by the alternative approach of ICP (Pt/CNTF-2).



Figure S4. ADT results for the catalyst of Pt/CNC. (a, b) TEM images of the CNCs, (c) TEM image of Pt/CNC catalyst, (d) CVs, (e) ORR polarization curves for various

numbers of potential cycling with a Pt loading of 53 μ g cm⁻² on the electrode, and (f) TEM image of Pt/CNC catalyst after 5k cycles. Scale bars, 50 nm (a), 10 nm (b, c), 20 nm (f).

Note that the size of the hollow cages was 20-50 nm with a shell thickness of 3-10 nm. The shell was composed of well-developed graphitic layers. Pt nanoparticles deposited on CNCs were fine and uniformly dispersed on the outer surfaces of CNCs and the average size was about 3 nm. Both CVs and ORR polarizataion curves showed fast catalyst degradation even within the first 1000 cycles. The average size of Pt was about 10 nm after cycling.



Figure S5. ADT results for the catalyst of Pt/C. (a) TEM image of Pt/C, (b) CVs, (c) ORR polarization curves for various numbers of potential cycling with a Pt loading of 53 μ g cm⁻² on the electrode, and (d) TEM image of Pt/C after 3000 cycles. Scale bars, 20 nm (a, d).

Note that the average Pt particle size of this commercial catalyst was about 3.6 nm. After potential cycling, Pt particles dissolved and redeposited to larger sizes (~9 nm). Both CVs and ORR polarization curves showed fast catalyst degradation even within the first 1000 cycles.



Figure S6. TEM images of Pt/CNTF-1 catalyst after 8000 ADT cycles. Scale bars, 200 nm (a) and 20 nm (b).



Figure S7. ADT results for Pt/CNTF-1 catalyst. (a, c, e) A set of the rotation-rate-dependent current-potential curves, and (b, d, f) Koutecky-Levich plots at various potentials after 1k, 3k, and 5k cycles.



Figure S8. ADT results for commercial Pt/C and Pt/CNTF catalysts. (a) A set of the rotation-rate-dependent current-potential curves, (b) Koutecky-Levich plots at various potentials for Pt/C catalyst before ADT cycling, (c) Kinetic current (i_k) versus cycling number for Pt/C and Pt/CNTF-1 with 53 µg cm⁻² of Pt loading for the case of 0.7 V, and (d) Plots of area-specific activity (A_s) versus cycling number for the case of 53 µg cm⁻² Pt loading.