

Supporting Information

Carbon-encapsulated PtPd alloy electrocatalyst on single-walled carbon nanotubes for durable polymer electrolyte fuel cell

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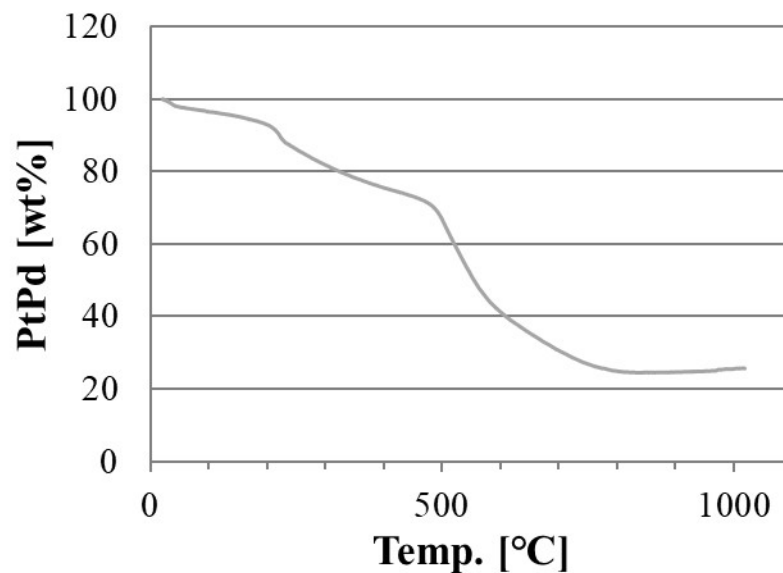


Figure S1. TGA profiles of PtPd@C/SWCNT.

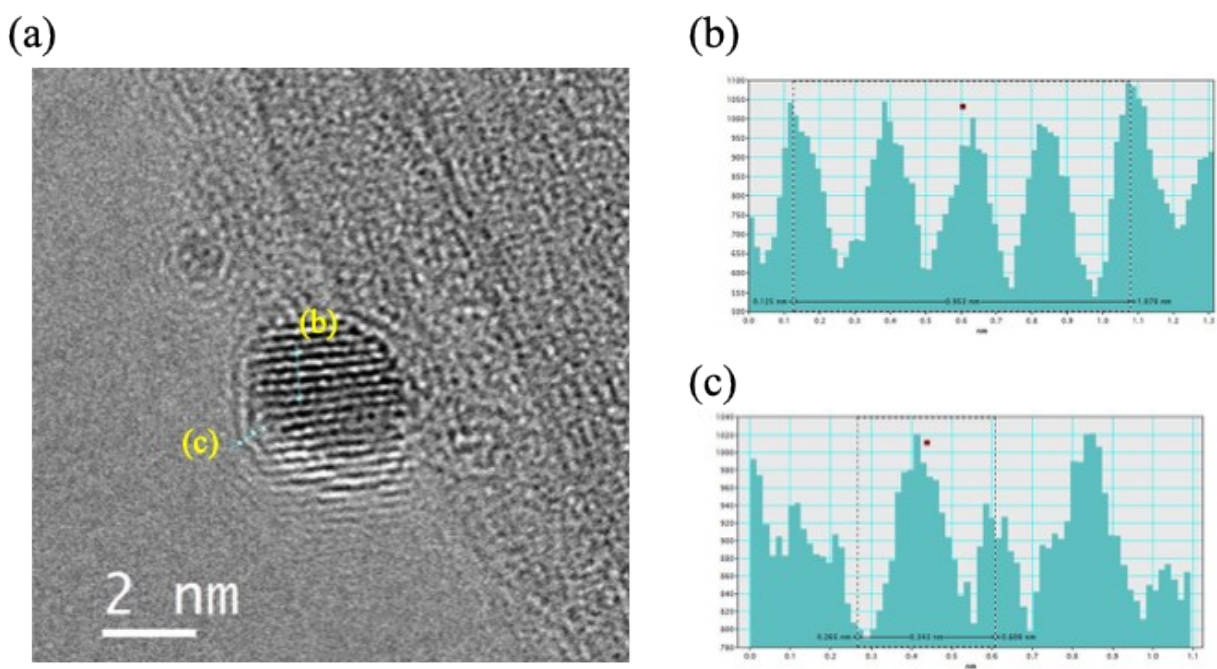


Figure S2. (a) High-resolution TEM (HRTEM) image and (b-c) line profiles of PtPd@C/SWCNT.

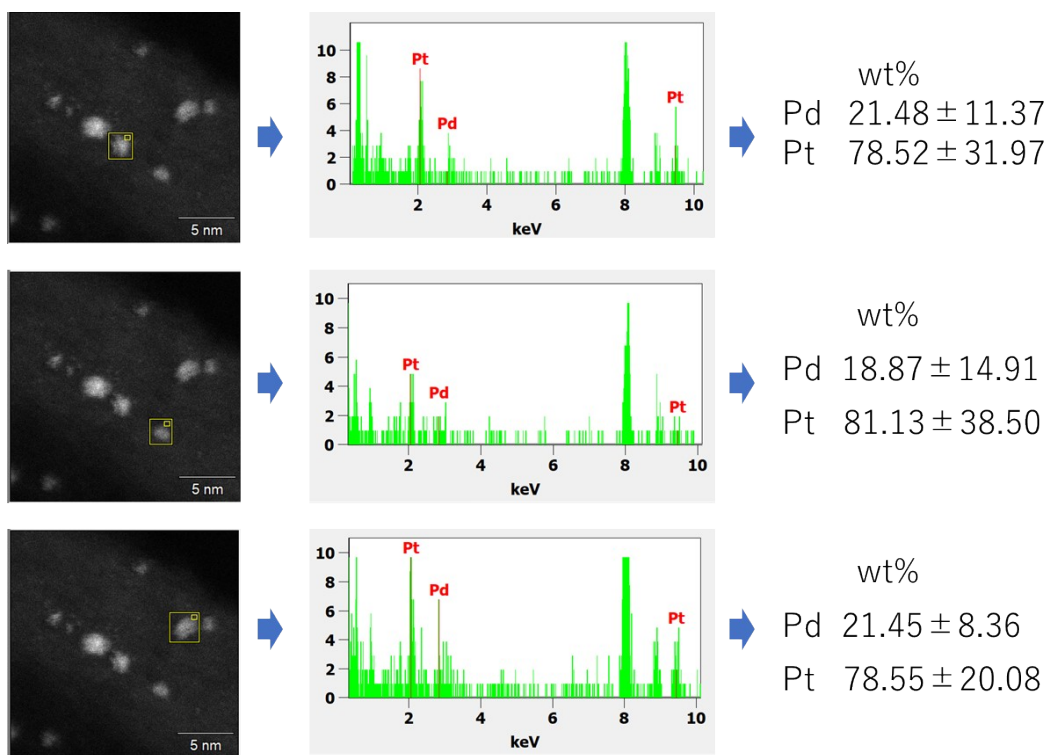


Figure S3. EDS area mappings for PtPd@C/SWCNT, including corresponding spectra and quantitative analysis.

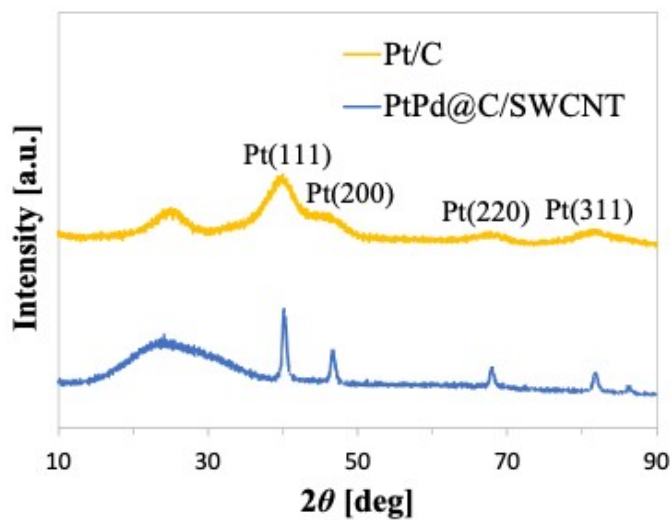


Figure S4. XRD measurements of commercial Pt/C and PtPd@C/SWCNT.

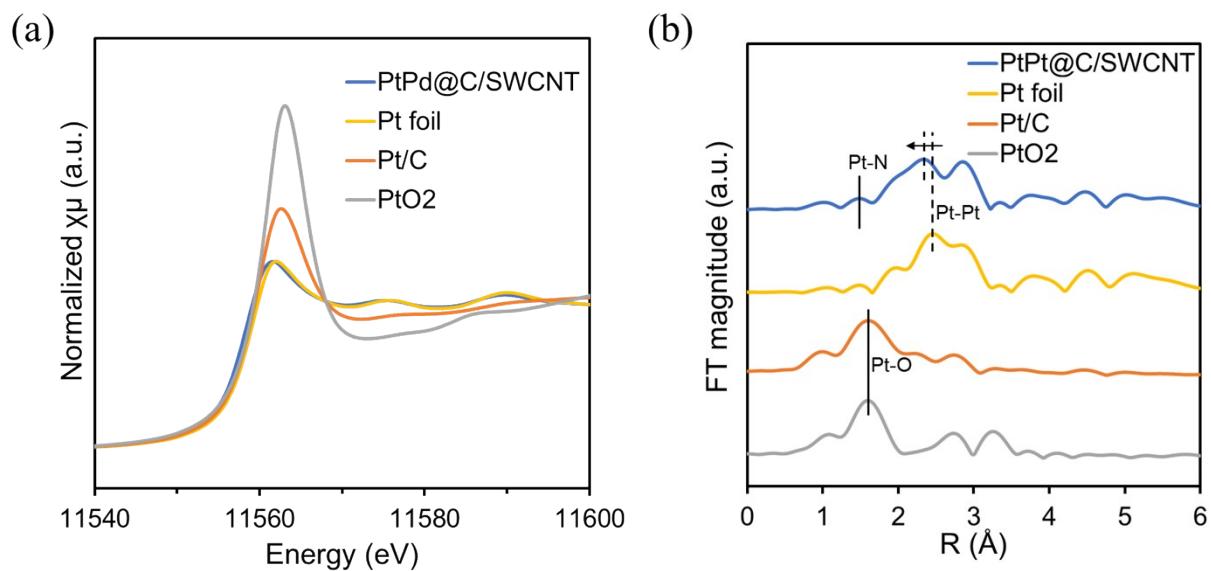


Figure S5. (a) XANES of Pt L_3 -edge for PtPd@C/SWCNT, commercial Pt/C, and references, (e) Corresponding FT-EXFAS for PtPd@C/SWCNT, commercial Pt/C, and references.

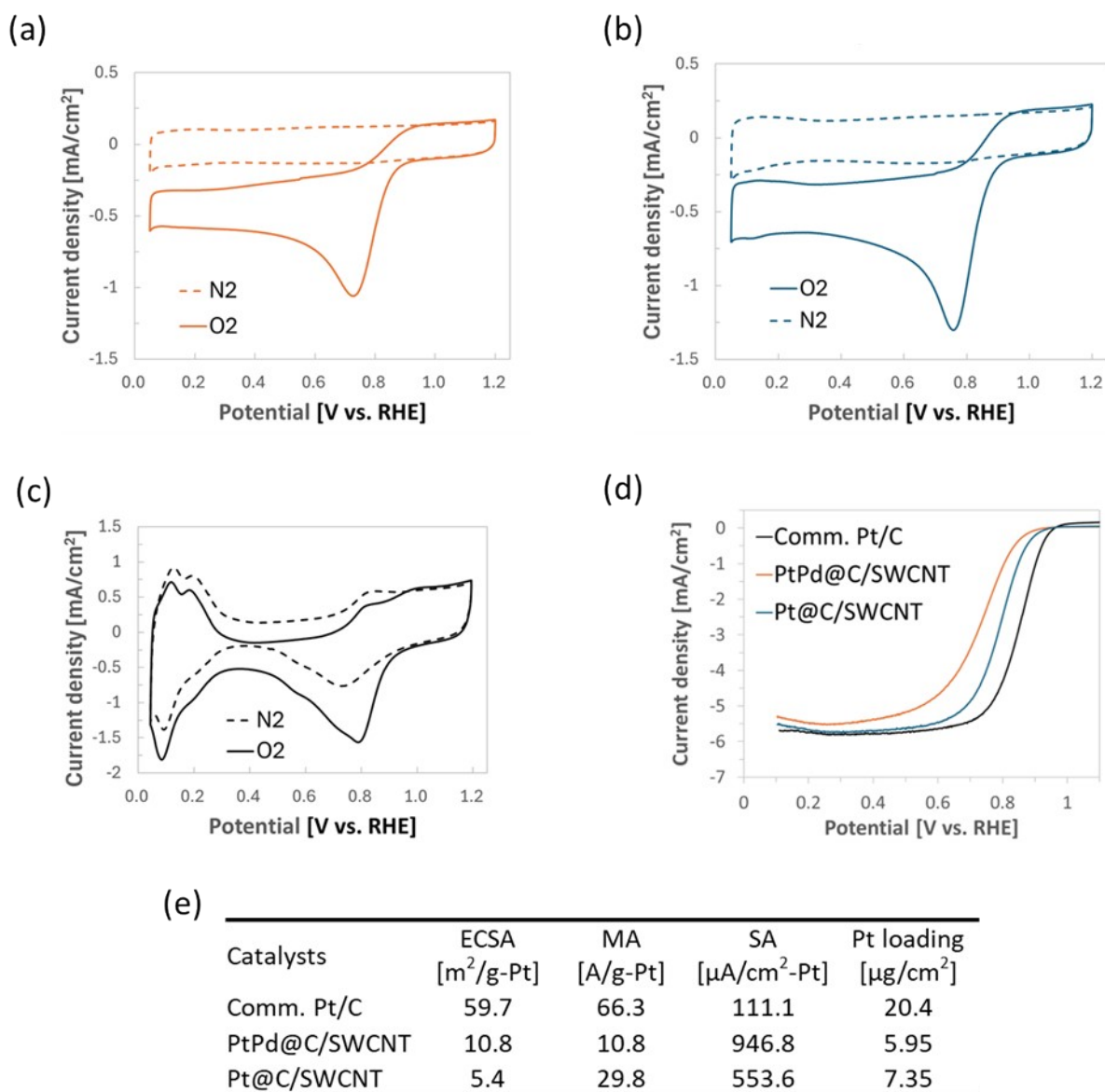


Figure S6. RDE measurements. CV curves of (a) PtPd@C/SWCNT, (b) Pt@C/SWCNT, and (c) commercial Pt/C. (d) LSV curves of PtPd@C/SWCNT, Pt@C/SWCNT, and Pt/C measured at 1600 rpm of electrode disk rotation. (e) Measured electrochemical performance of catalysts.

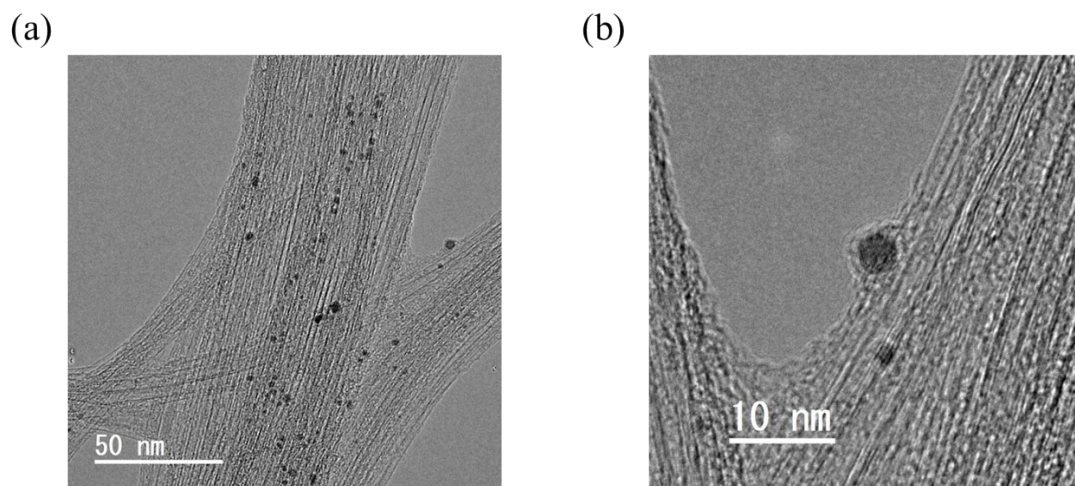


Figure S7. TEM images of Pt@C/SWCNT.

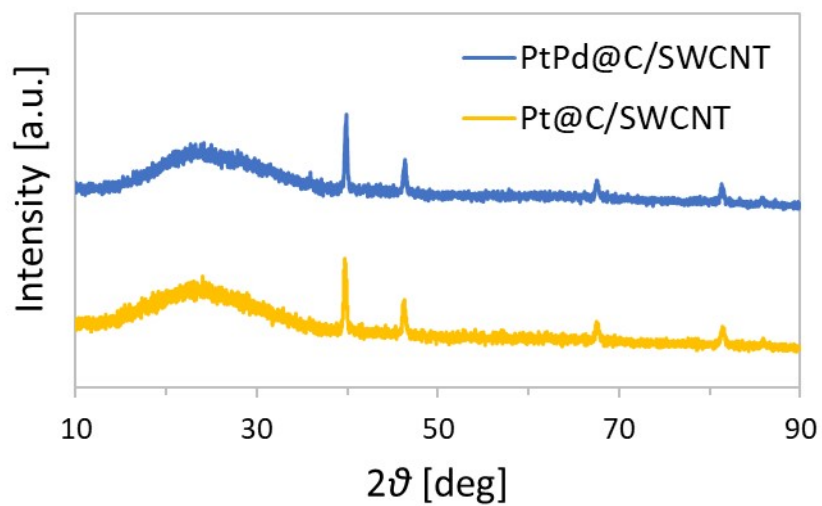


Figure S8. XRD spectra of PtPd@C/SWCNT and Pt@C/SWCNT employed for RDE measurements.

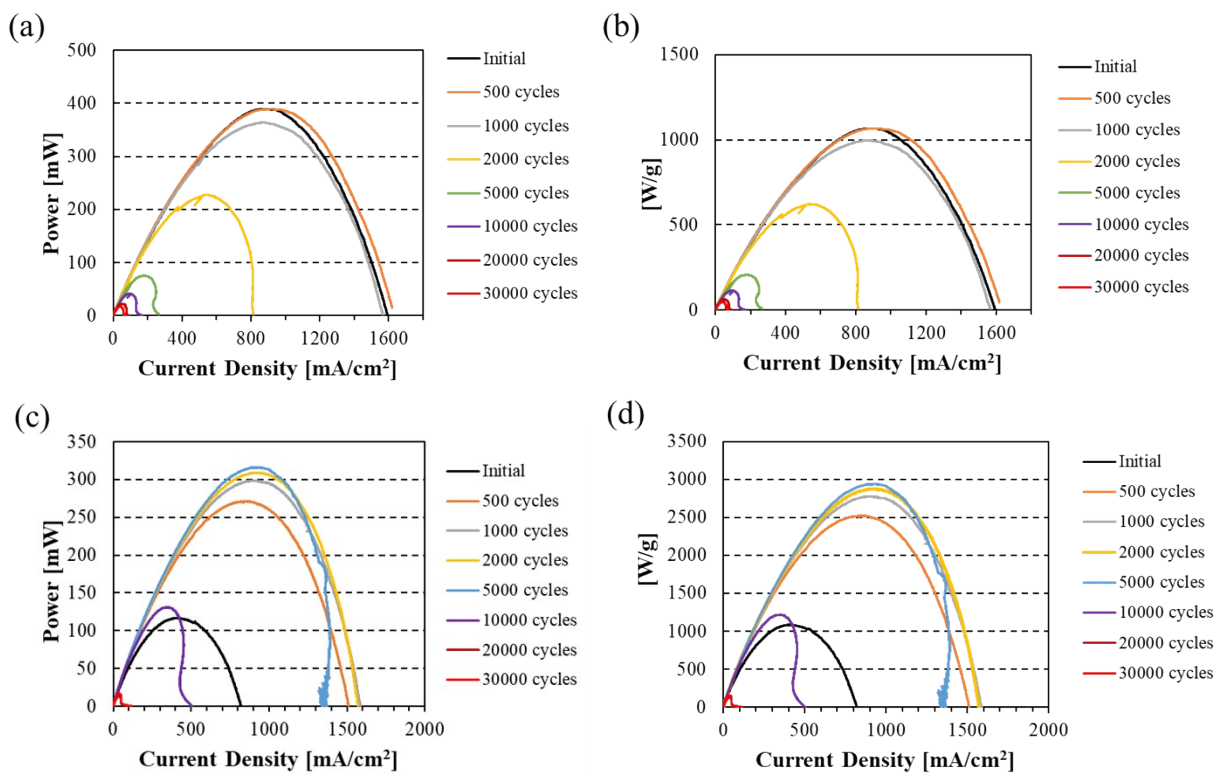


Figure S9. The power density and the power density per mass of Pt generated by (a,b) Pt/C and (c,d) PtPd@C/SWCNT-MEA, respectively.

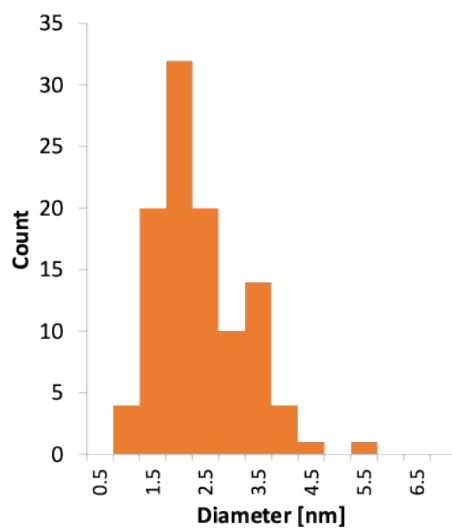


Figure S10. The size distribution of PtPd alloy nanoparticles after the durability test.

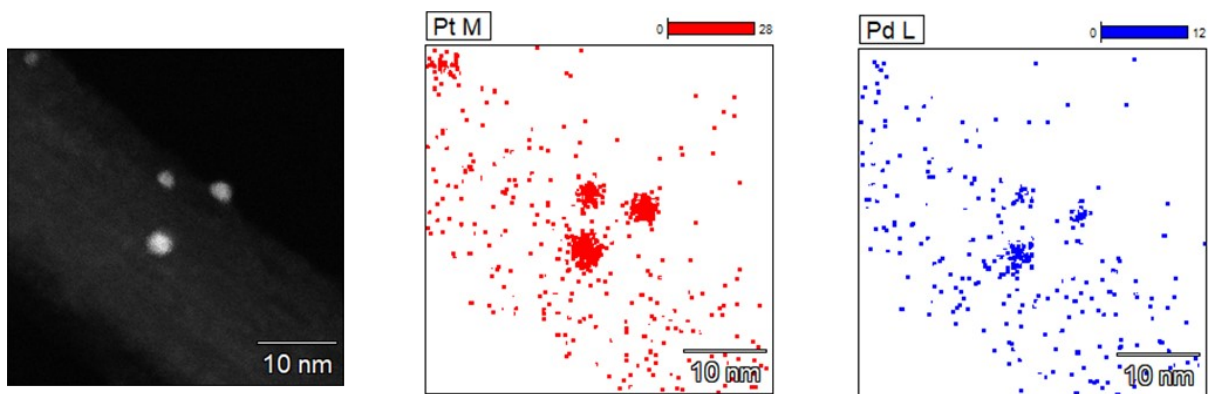


Figure S11. EDS observation of PtPd@C/SWCNT performed after the durability test.

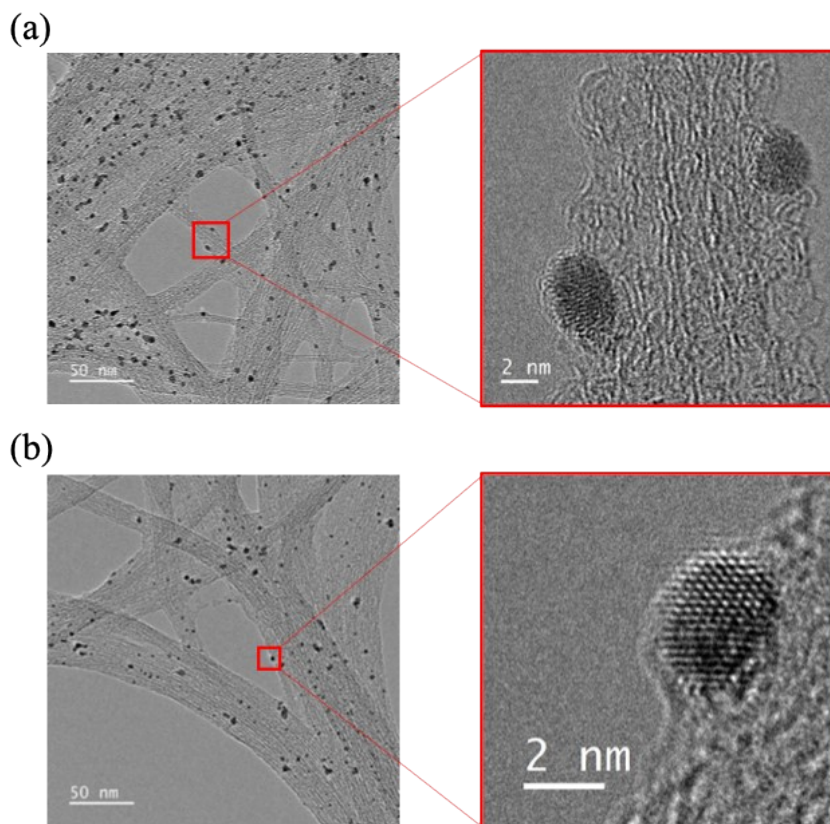


Figure S12. HR-TEM images of PtPd@C/SWCNT obtained after the durability test.

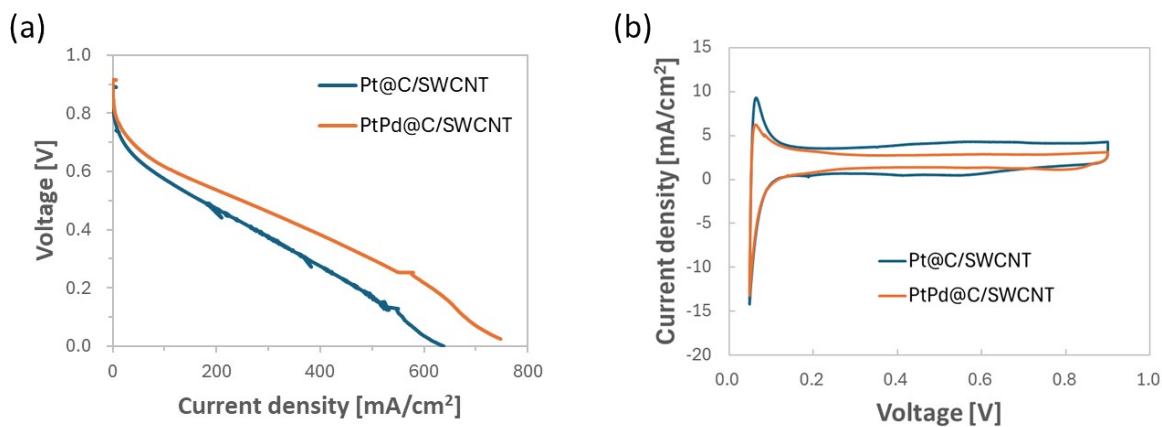


Figure S13. Single cell measurements. (a) I–V and (b) CV curves of MEAs with Pt@C/SWCNT (Pt loading 73 $\mu\text{g}/\text{cm}^2$) and PtPd@C/SWCNT (Pt loading 59 $\mu\text{g}/\text{cm}^2$) as cathode catalyst.

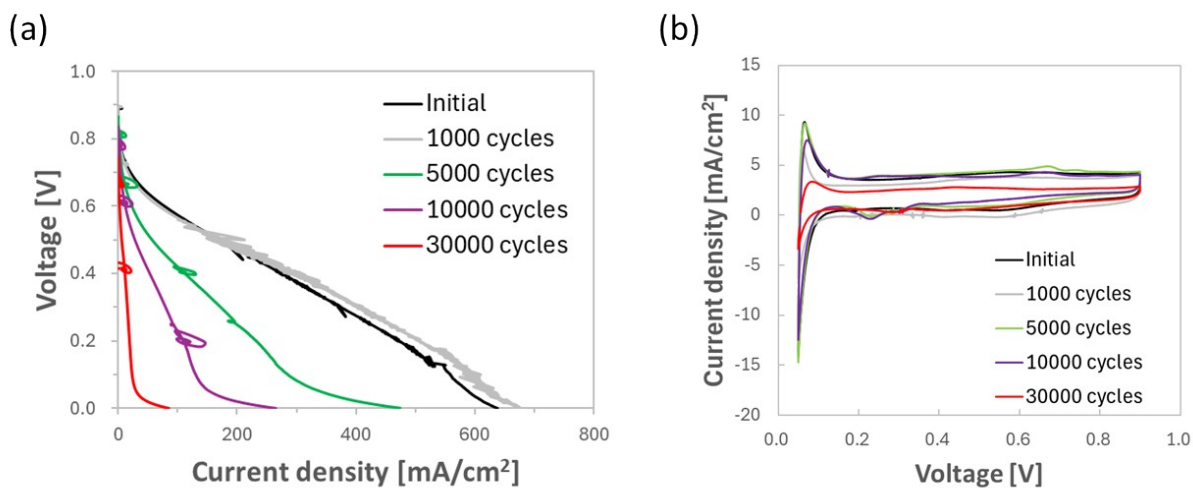


Figure S14. Durability test. (a) I–V and (b) CV curves of MEAs with Pt@C/SWCNT as cathode catalyst recorded during start-up/shut-down durability test.

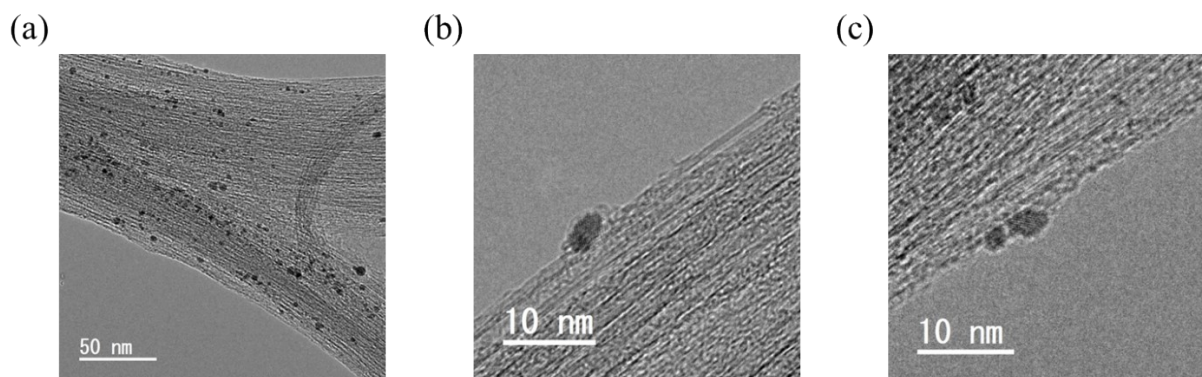


Figure S15. TEM images of Pt@C/SWCNT after treated with start-up/shut-down durability test of 30,000 cycles.

Table S1. The crystallinity of SWCNT calculated from Raman spectroscopy measurements on pristine SWCNT, PtPd@C/SWCNT before the durability test, and PtPd@C/SWCNT after the durability test, as shown in Fig. 5(a).

Sample	The crystallinity of SWCNT (Id/Ig)
SWCNT	0.013
PtPd@SWCNT before the durability test	0.014
PtPd@SWCNT after the durability test	0.053

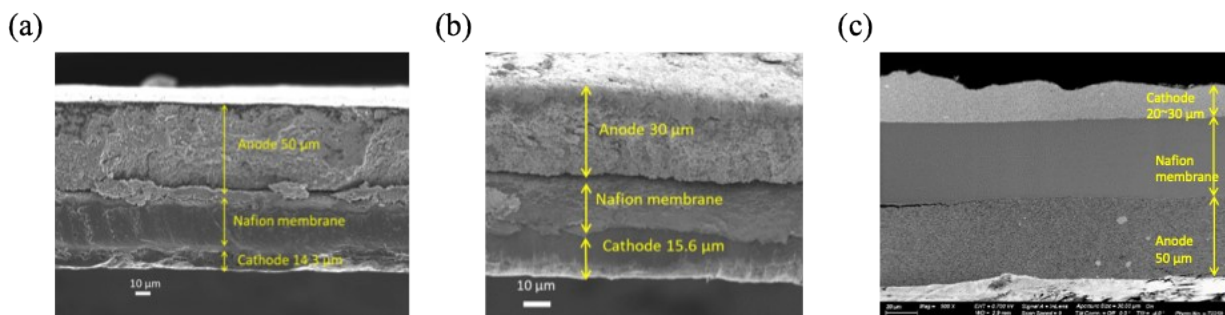


Figure S16. Cross-sectional scanning electron microscope (SEM) images of PtPd@C/SWCNT-MEA obtained (a) before and (b) after the durability test. (c) Cross-sectional SEM image of Pt/C-MEA obtained after the durability test.

Prior to the durability test, the structure of the cathode catalyst layer in the Pt/C-MEA was similar to that of the anode catalyst layer. This is because the anode catalyst layer was held at 0 V throughout the test, preventing any stress or corrosion.

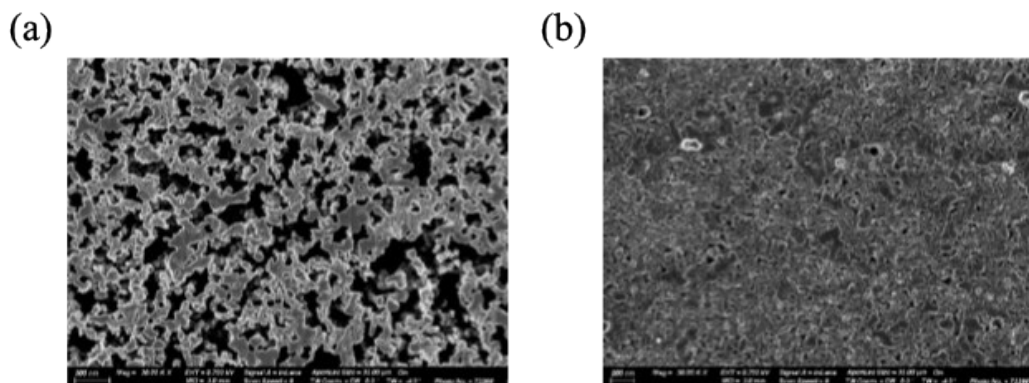


Figure S17. Cross-sectional SEM images of Pt/C-MEA obtained after the durability test. (a) Anode catalyst layer, (b) cathode catalyst layer.

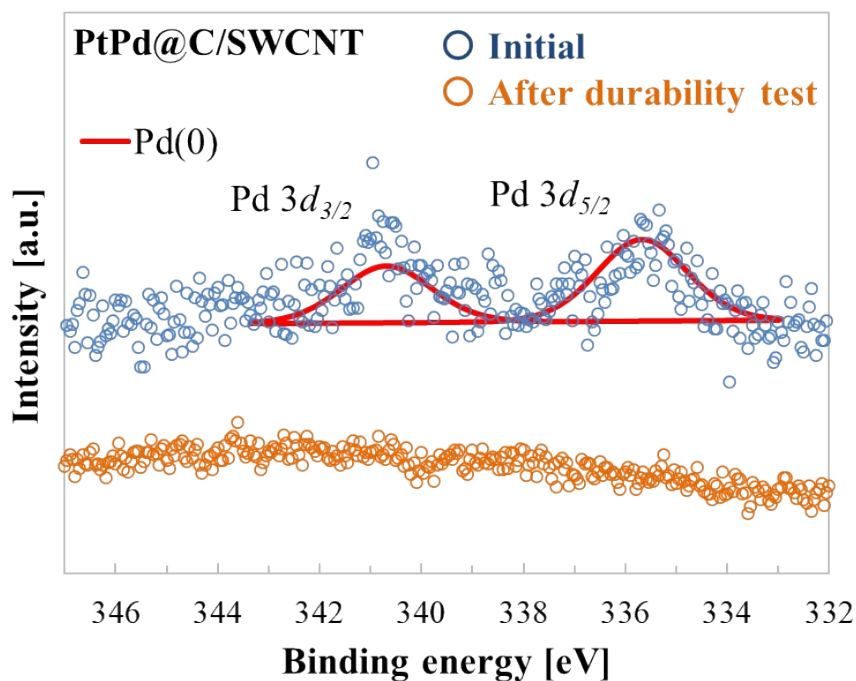


Figure S18. XPS Pd 3d spectra of PtPd@C/SWCNT catalyst obtained before and after the durability test.