

Supplementary Information

for

Hydrophobic Modification Enhances the Microstructure Stability of the Catalyst Layer in Alkaline Polymer Electrolyte Fuel Cells

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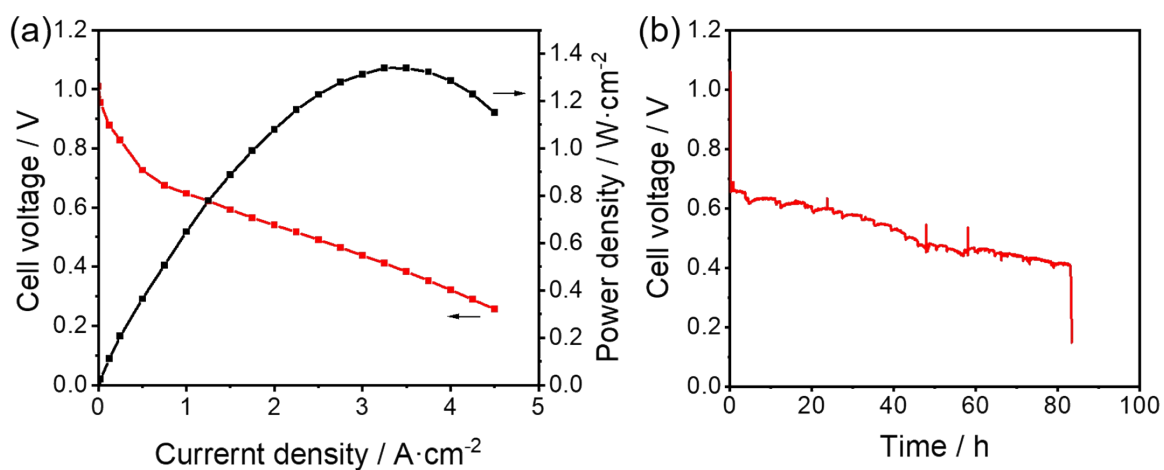


Figure S1. Polarization curve and durability test of the APEFC with a conventional MEA. (a) polarization curve of the APEFC with a Pt loading of 0.2 mg cm⁻² at 80 °C with a back pressure of 0.2 MPa. (b) the durability test results of the APEFC measured at a constant current density of 1 A cm⁻².

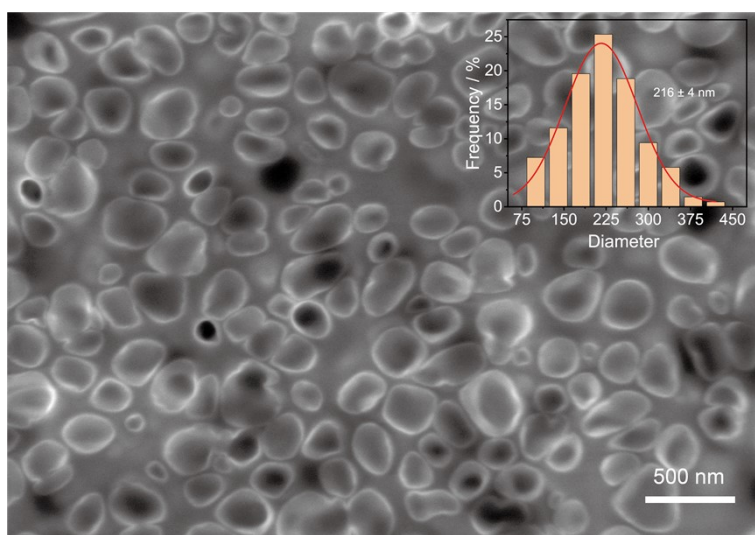


Figure S2. SEM image of PTFE particles. Its average diameter is 216 ± 4 nm.

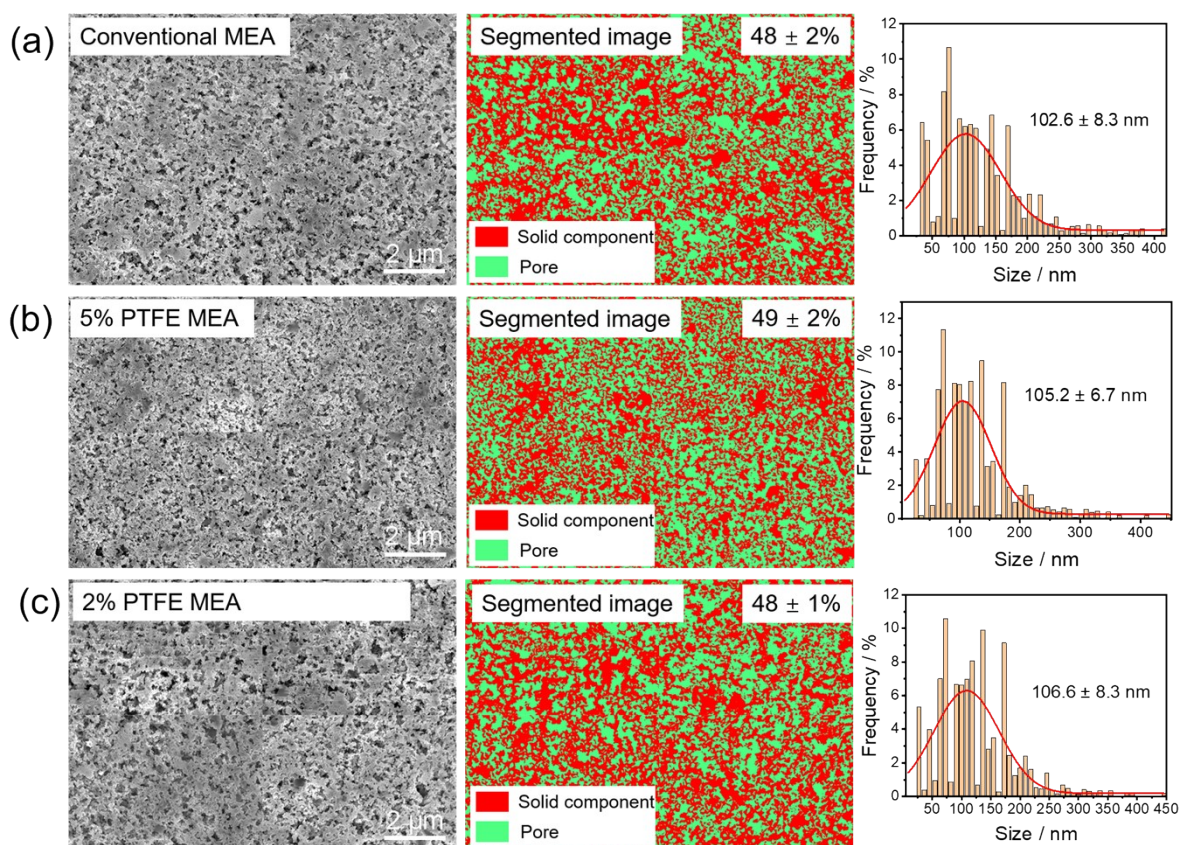


Figure S3. The initial SEM images and segmented images of the conventional MEA (a), 5% PTFE MEA (b) and 2% PTFE MEA (c) before durability test. The rightmost column represents the statistical average size of the solid phase, calculated using the local thickness method.

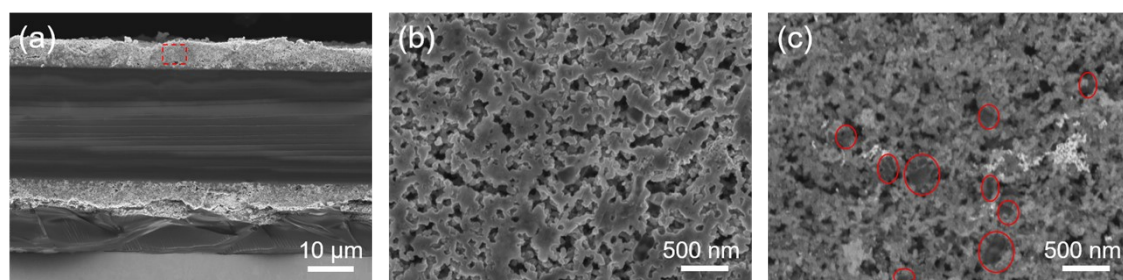


Figure S4. Cross-sectional structure of the 5% PTFE MEA catalyst layer. (a) the macroscopic structure of PTFE MEA cross section. (b) and (c) local enlargements in the red box in (a), where (b) is captured in SE mode and (c) is captured in BSE mode. The red boxes marked in (c) are PTFE particles.

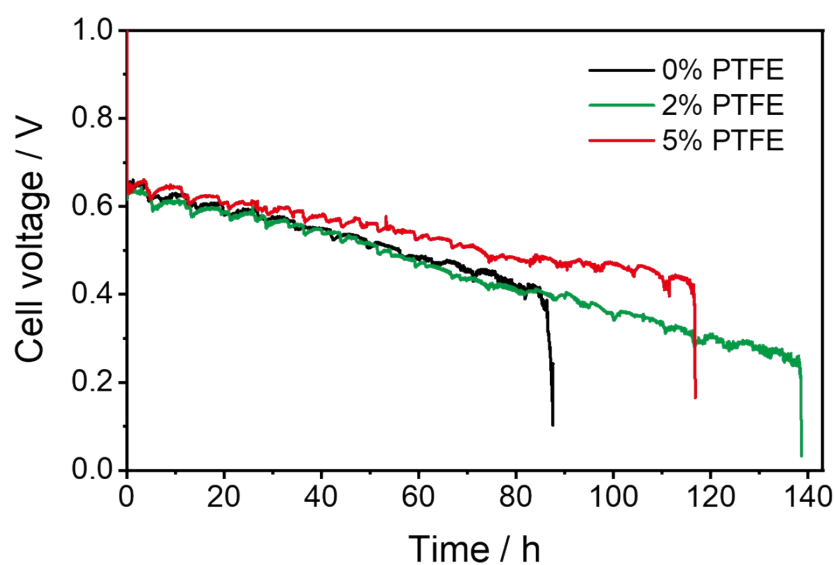


Figure S5. Repeated durability tests of PTFE MEAs and conventional MEA. The durability test is set at a current density of 1 A cm^{-2} , with a back pressure of 200 kPa and a temperature of $80 \text{ }^\circ\text{C}$, and the flow rate was 1000 mL min^{-1} .

Table S1. Durability of APEFC in other reports and in this work

APEFC	Current density (A cm^{-2})	Durability (h)	Voltage decay rate (mV h^{-1})	Ref
QAPPT MEA	0.2	125	~ 1	32
QAPPT MEA	0.6	60	2.7	16
QAPPT MEA	1.0	83	3.1	This work
2%PTFE+QAPPT MEA	1.0	130	2.9 (first 80 h)	This work
5%PTFE+QAPPT MEA	1.0	120	2.4	This work

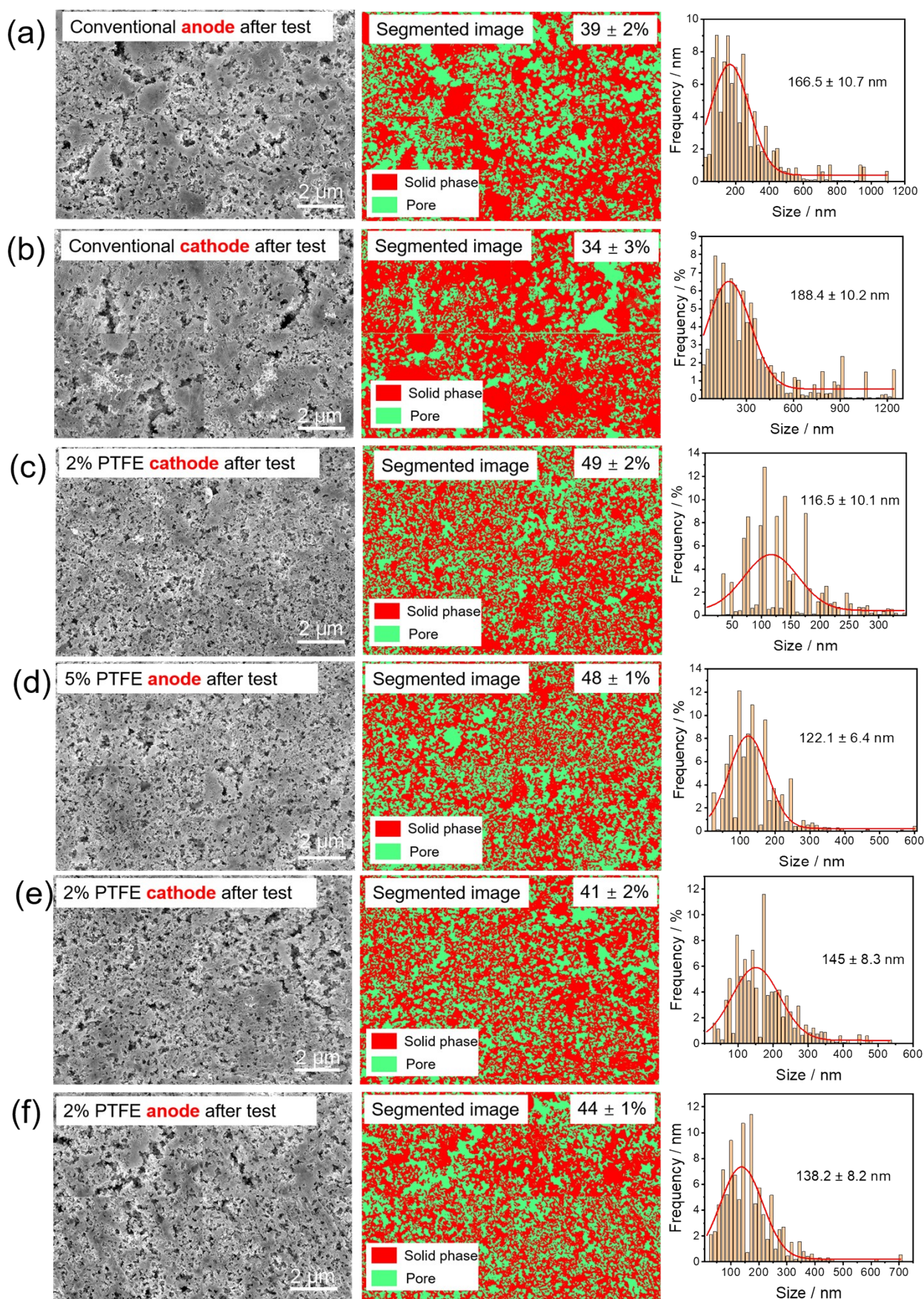


Figure S6. Quantitative analysis of the pore structure in MEA catalyst layers with different PTFE contents. Panels (a) and (b) show the cathode and anode catalyst layer structures after the

durability test in conventional MEA. Panels (c) and (d) present these structures in the MEA with 5% PTFE, also after the durability tests. (e) illustrates the catalyst layer structure in a 2% PTFE MEA before the durability test. Panels (f) and (g) exhibit the cathode and anode catalyst layer structures after the durability test in 2% PTFE MEA. The left column displays the original SEM images. The middle column represents the segmented images using image segmentation method based on machine learning, while the right column shows the statistical average size of solid phase, calculated using the local thickness method.

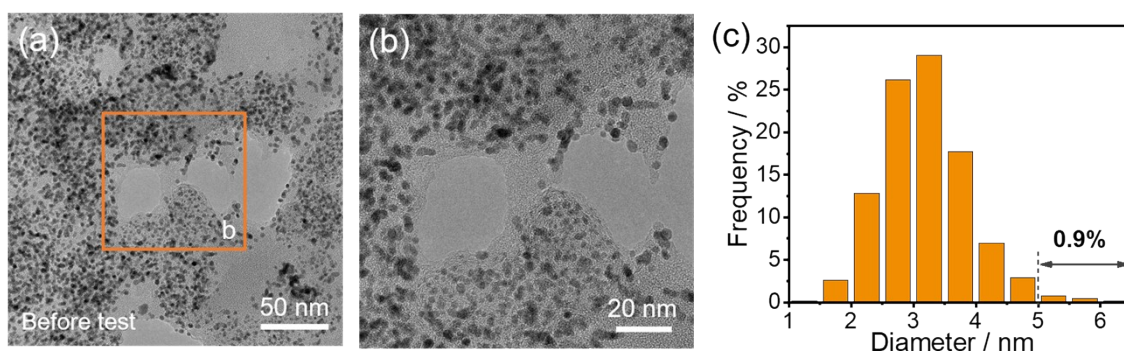


Figure S7. (a, b) Representative TEM images of Pt nanoparticles before the durability test. (c) Histograms depicting the size distribution of the Pt nanoparticles, with over 1000 particles counted.

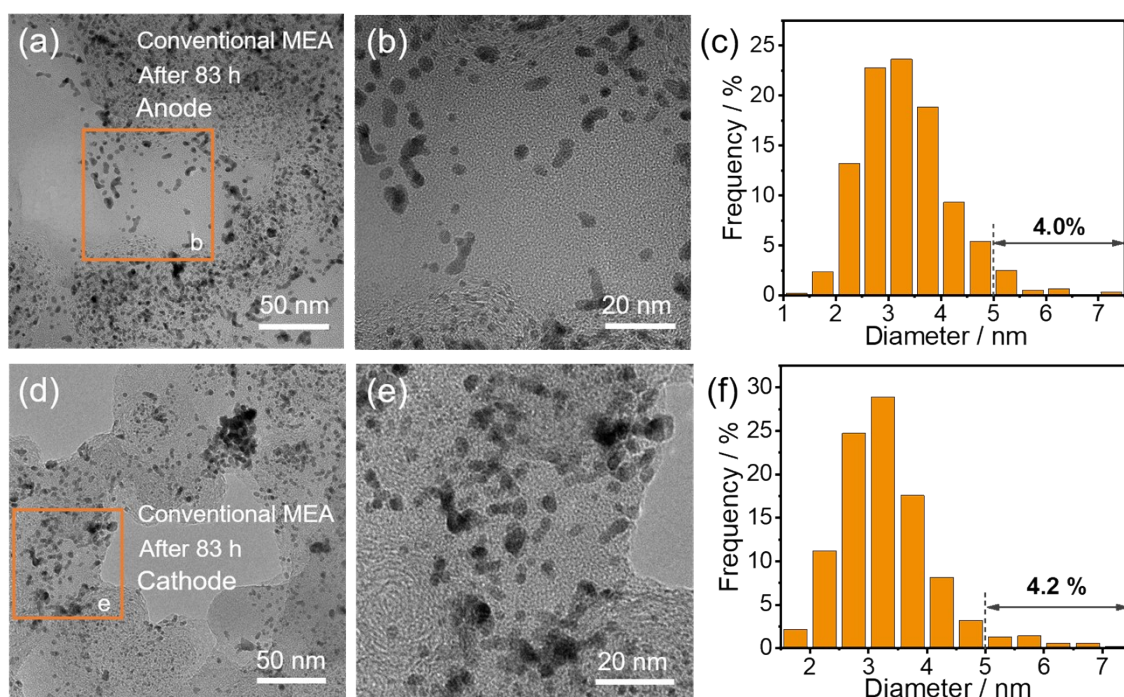


Figure S8. (a, b) Representative TEM images of Pt nanoparticles at the anode side of conventional MEA after the durability test. (d, e) Representative TEM images at the cathode side after the durability test. (c, f) Histograms depicting the size distribution of the Pt nanoparticles, with over 1000 particles counted.

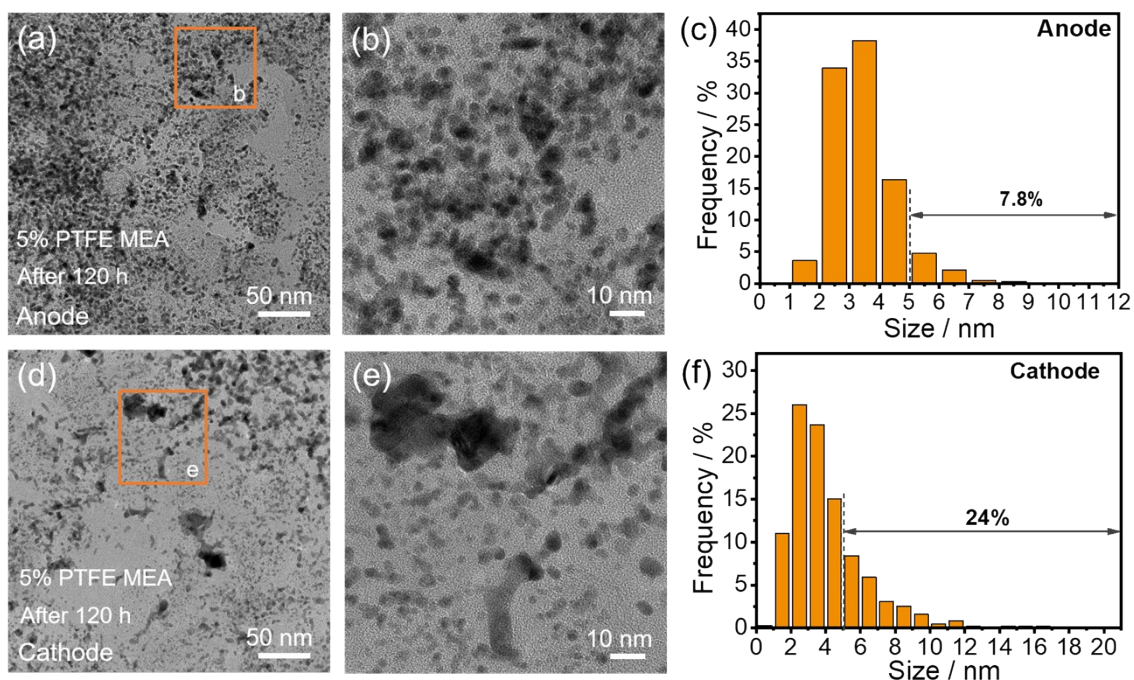


Figure S9. (a, b) Representative TEM images of Pt nanoparticles at the anode side of 5% PTFE MEA after the durability test. (d, e) Representative TEM images at the cathode side. (c, f) Histograms depicting the size distribution of the Pt nanoparticles, with over 1000 particles counted.