

Supplementary materials

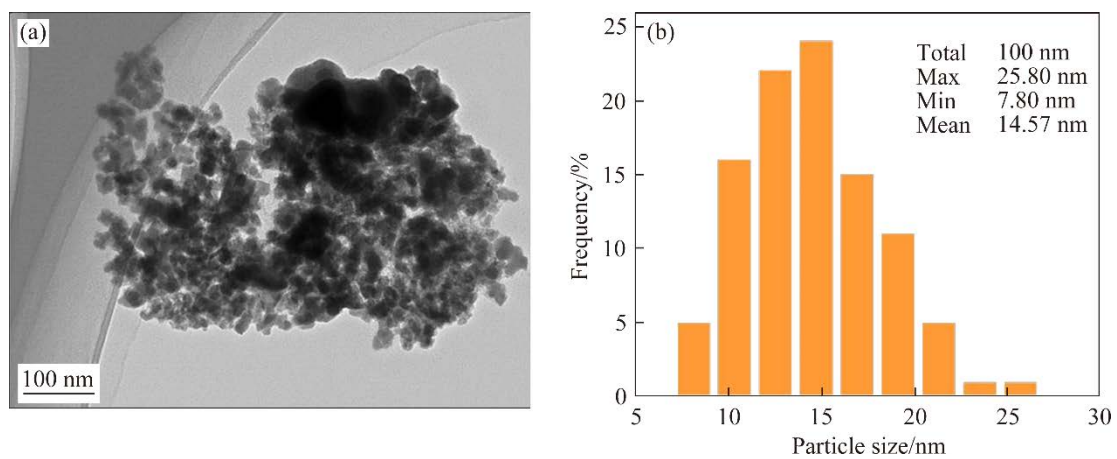


Figure S1 (a) TEM image and (b) particle size distribution of IrO₂ nanoparticles

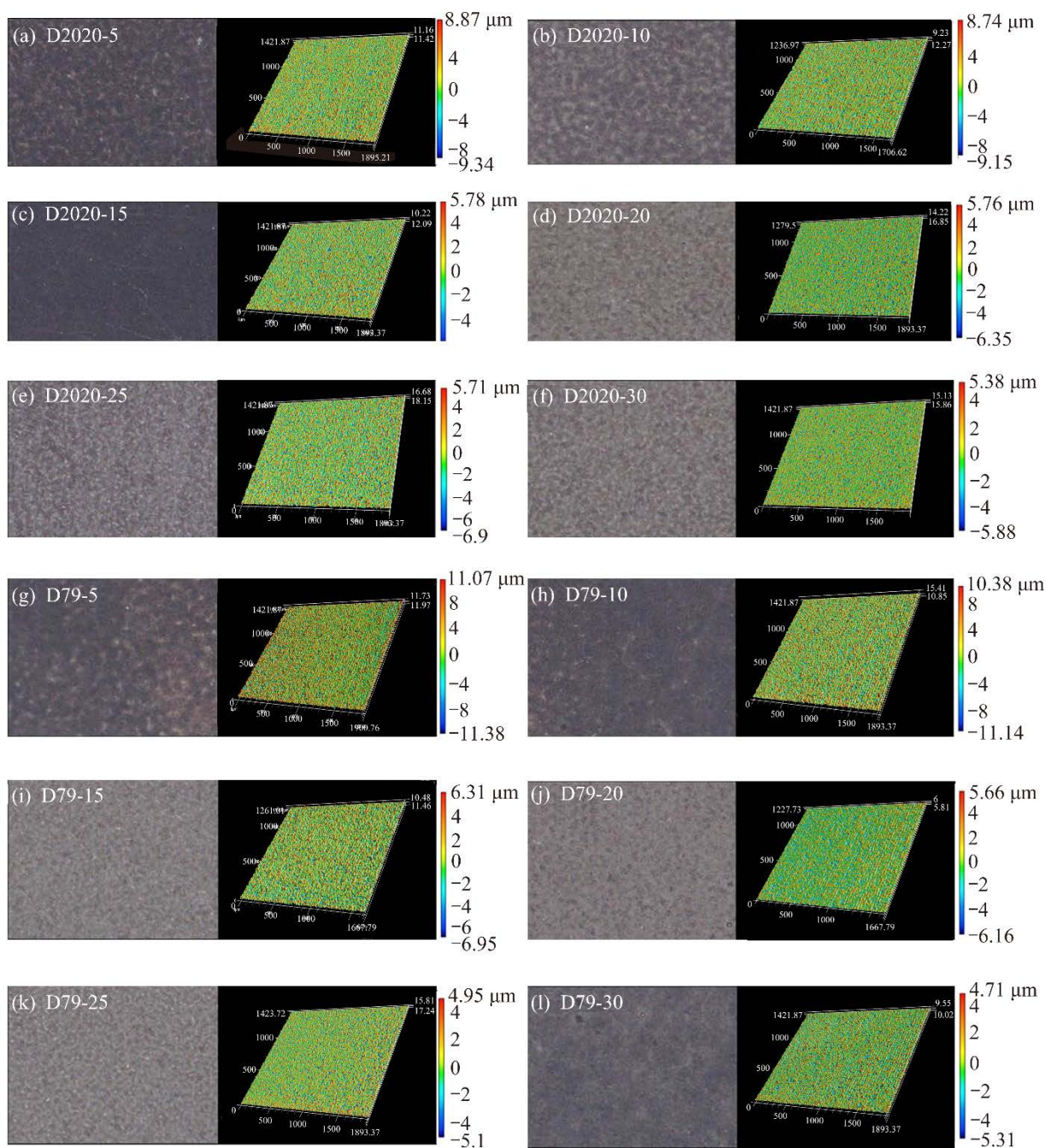


Figure S2 Optical images and according 3D profilometer images of IrO_2 catalytic layer with varying content of (a–f) D2020 ionomers and (g–i) D79 ionomers

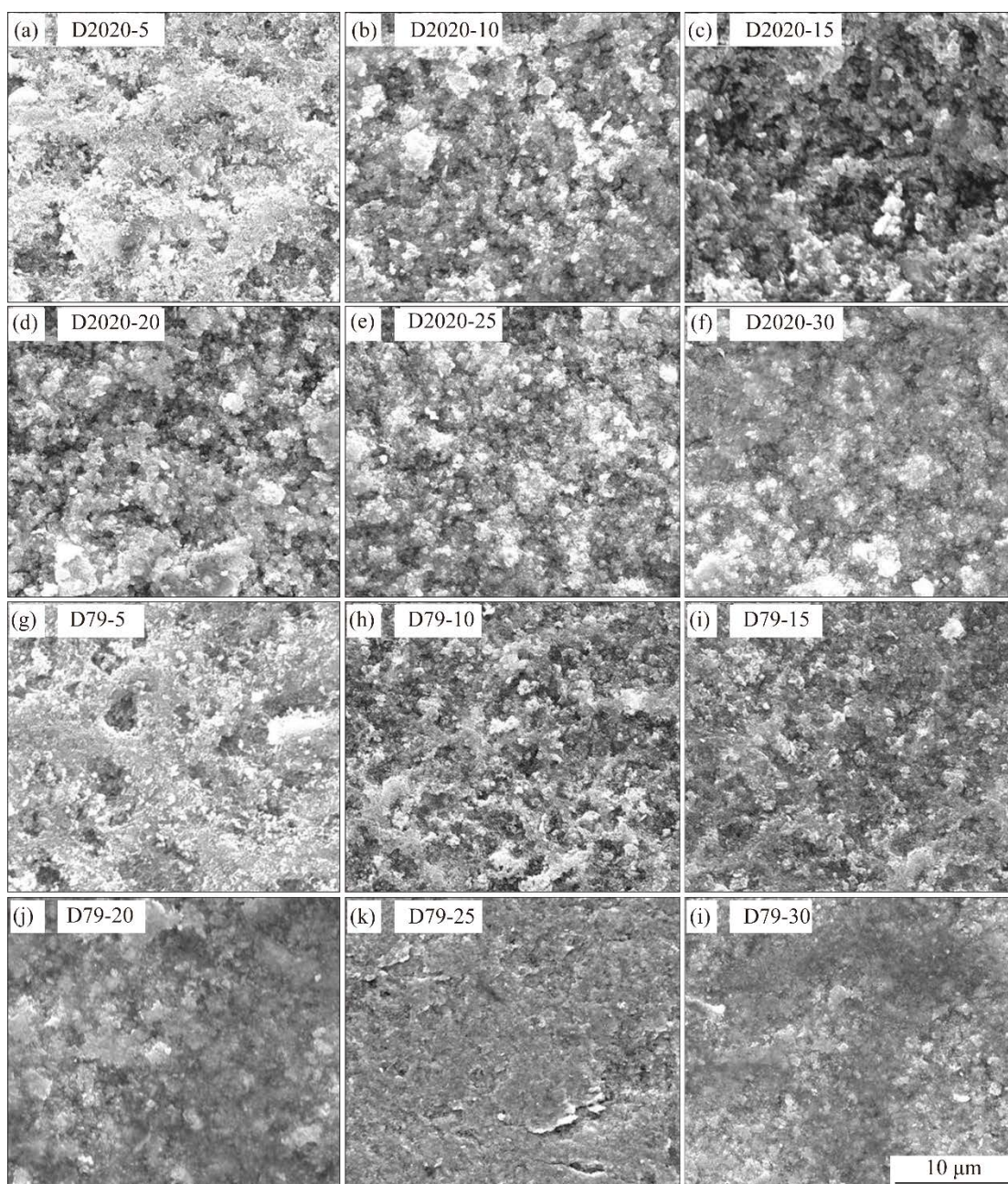


Figure S3 Optical images and according 3D profilometer images of IrO₂ catalytic layer with varying content of (a–f) D2020 ionomers and (g–i) D79 ionomers

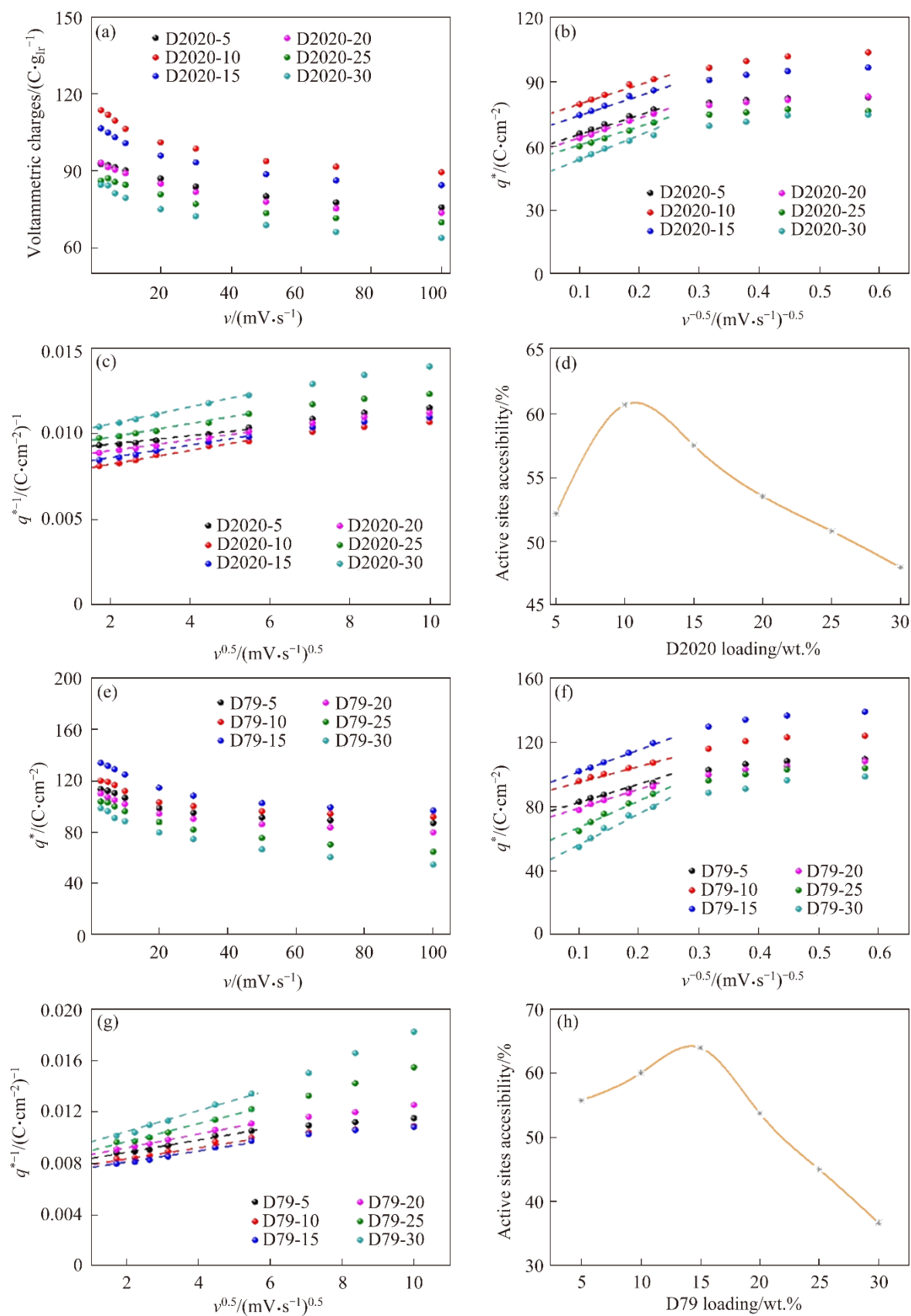


Figure S4 Voltammetric charge q^* vs. scanning rate of IrO₂ catalytic layer with different I/Ir mass ratios of (a) D2020 and (e) D79; q^{*-1} vs. $v^{0.5}$ curves of (b) D2020 and (f) D79; q^* vs. $v^{-0.5}$ curves of (c) D2020 and (g) D79; Active sites accessibility ($q^*_{\text{Out}}/q^*_{\text{Total}} \times 100\%$) of (d) D2020 and (h) D79

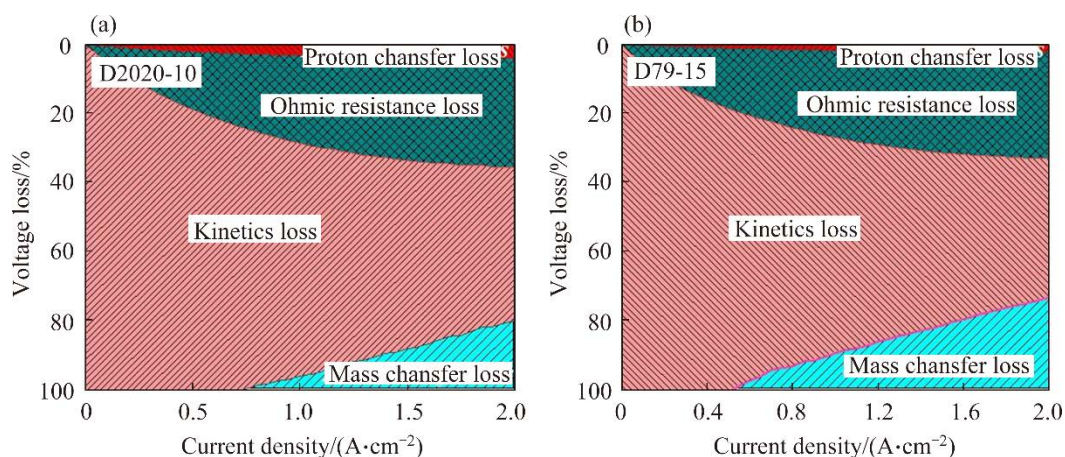


Figure S5 Contributions of various voltage losses of (a) D2020-10 and (b) D79-15

Table S1 Tafel, R_{Ω} and R_{ct} values of MEA with varying content of D2020 and D79

Ionomer	Ionomer loading/wt. %	Tafel value/(mV·dec ⁻¹)	$R_{\Omega}/(\Omega \cdot \text{cm}^2)$	$R_{ct}/(\Omega \cdot \text{cm}^2)$
D2020	5	81.27	0.152	0.118
	10	78.64	0.154	0.096
	15	79.17	0.155	0.111
	20	80.33	0.156	0.119
	25	81.33	0.157	0.129
	30	83.26	0.158	0.139
D79	5	78.87	0.152	0.111
	10	74.99	0.153	0.096
	15	66.51	0.156	0.079
	20	78.2	0.158	0.123
	25	85.34	0.159	0.136
	30	88.31	0.16	0.151

Table S2 Proton resistance and proton conductivity of IrO₂ catalytic with different ionomer loadings

Ionomer	I/Ir mass ratio/wt. %	Proton resistance/(m $\Omega \cdot \text{cm}^2$)					Proton conductivity/(mS·cm ⁻¹)				
		50 °C	60 °C	70 °C	80 °C	90 °C	50 °C	60 °C	70 °C	80 °C	90 °C
D2020	5	27.7	26.3	24.3	21.9	19.7	83.75	88.21	95.47	105.94	117.77
	10	25.1	24.1	22.1	20.0	18.0	84.86	88.38	96.38	106.50	118.33
	15	20.2	19.1	17.8	16.0	14.5	85.64	90.58	97.19	108.13	119.31
	20	19.5	18.6	16.6	15.7	14.2	100.00	104.84	117.47	124.20	137.32
	25	18.9	18.1	15.9	14.8	13.9	107.41	112.15	127.67	137.16	146.04
	30	17.3	16.8	14.7	13.9	13.7	139.31	143.45	163.95	173.38	175.91
D79	5	25.4	23.9	21.8	19.9	18.0	83.86	89.12	97.71	107.04	118.33
	10	19.2	18.8	17.6	16.2	14.9	92.19	94.15	100.57	109.26	118.79
	15	14.6	14.3	13.1	12.4	11.4	93.15	95.11	103.82	109.68	119.30
	20	14.2	13.8	13.0	11.6	11.2	111.27	114.49	121.54	136.21	141.07
	25	14.0	13.5	12.9	10.8	10.1	127.86	132.59	138.76	165.74	177.23
	30	13.6	12.9	11.7	10.3	10.0	141.18	148.84	164.10	186.41	192.01