An ultrafine iridium nanoparticle prepared without surfactant for acidic oxygen evolution reaction

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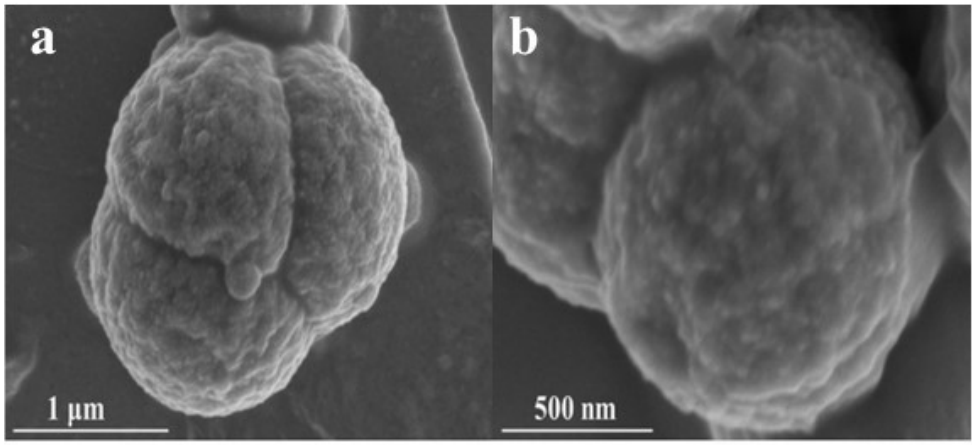

Fig. S1 SEM images of UF-Ir/IrO_x.

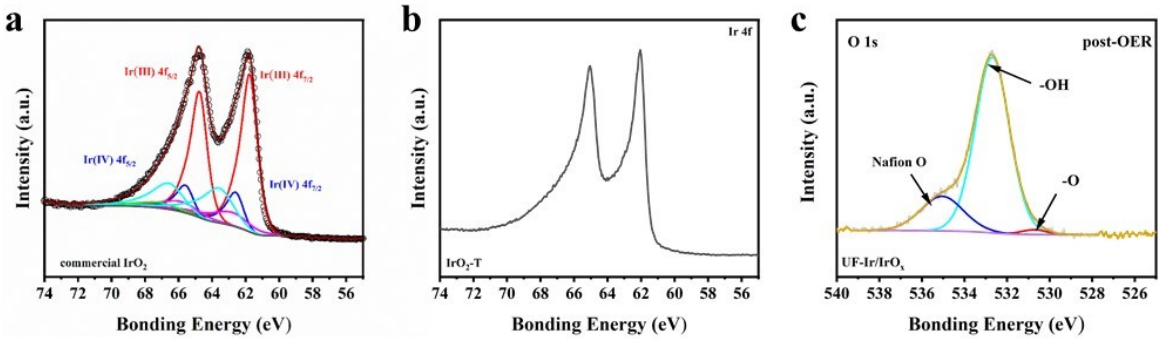

Fig. S2 High-resolution XPS spectra of (a) commercial IrO_2 and (b) IrO_2-T: Ir 4f. (c) O1s of UF-Ir/IrO_x after OER.

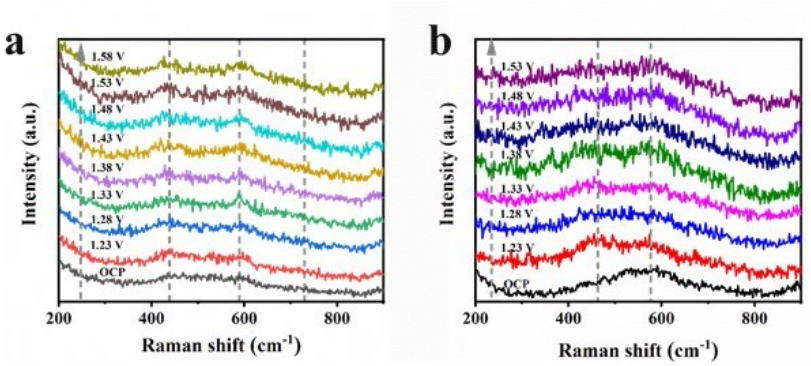

Fig. S3 *In situ* Raman spectra of (a) IrO_2-T/carbon paper and (b) commercial IrO_2/carbon in 0.5 M H_2SO_4 (with H_2O).

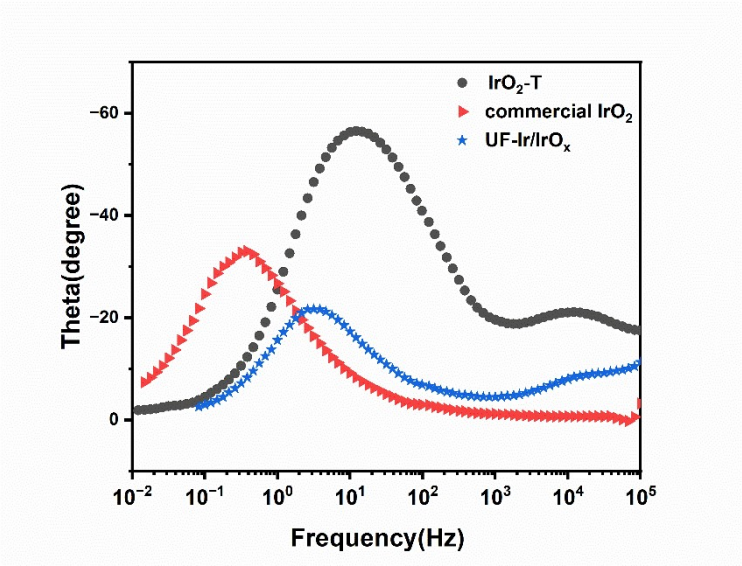

Fig. S4 Bode plots of UF-Ir/IrO_x, commercial IrO_2 and IrO_2-T.

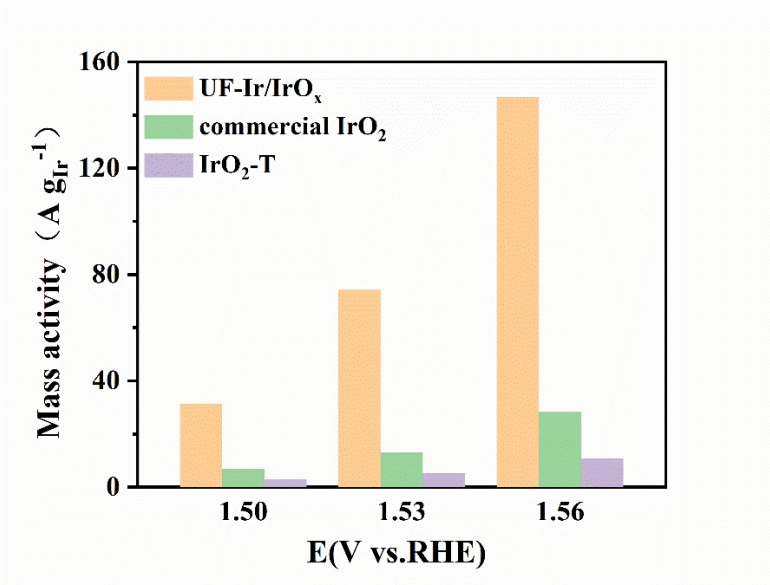

Fig. S5 Mass activity at different applied voltages of UF-Ir/IrO_x, commercial IrO_2 and IrO_2-T

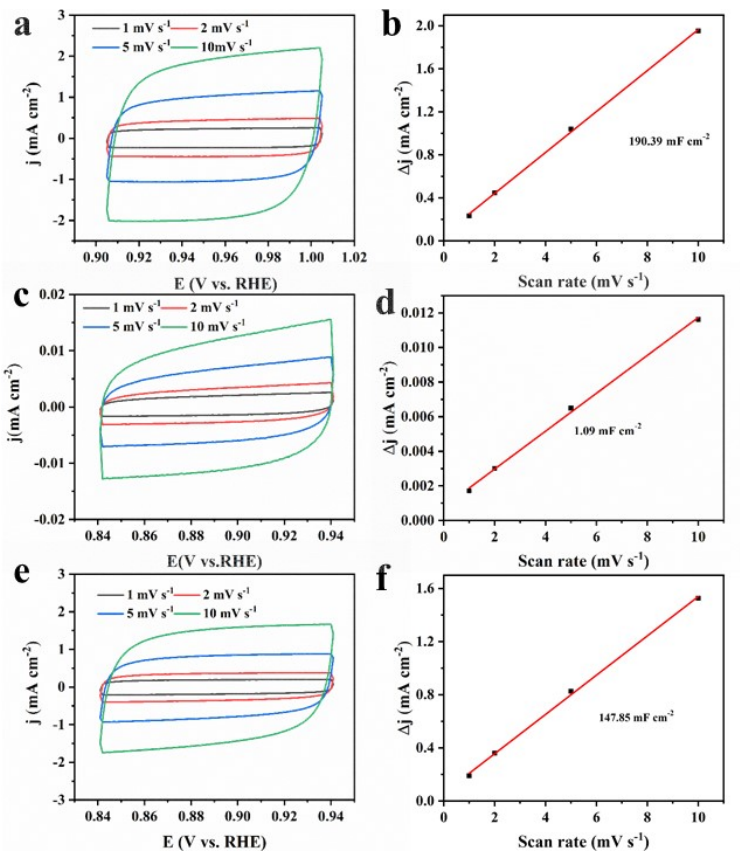

Fig. S6 (a) CV curves of UF-Ir/IrO_x at different scan rates (1, 2, 5, 10 mV/s) from 0.841 to 0.941 V vs. RHE. (b) The difference (△j) between capacitive currents as a function of scan rate to give the double-layer capacitance (C_{dl}) for UF-Ir/IrO_x. For comparison, CV curves of (c) IrO_2-T and (e) commercial IrO_2 at different scan rates (1, 2, 5, 10 mV/s) from 0.841 to 0.941 V vs. RHE are also measrued, and the corresponding Cdl values (d、f) are also calculated.

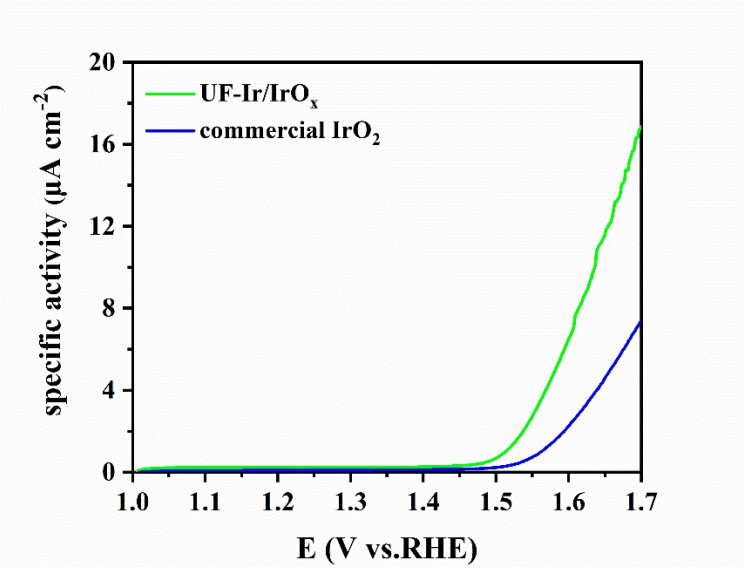

Fig. S7 ECSA-normalized LSVs for UF-Ir/IrO$_x$ and commercial IrO$_2$.

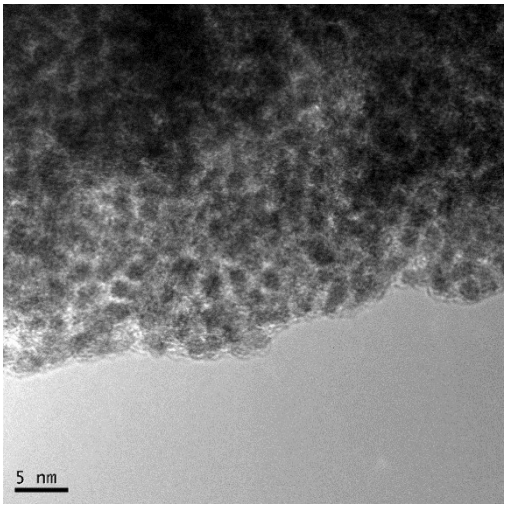

Fig. S8 HR-TEM image of UF-Ir/IrO_x after durability test.

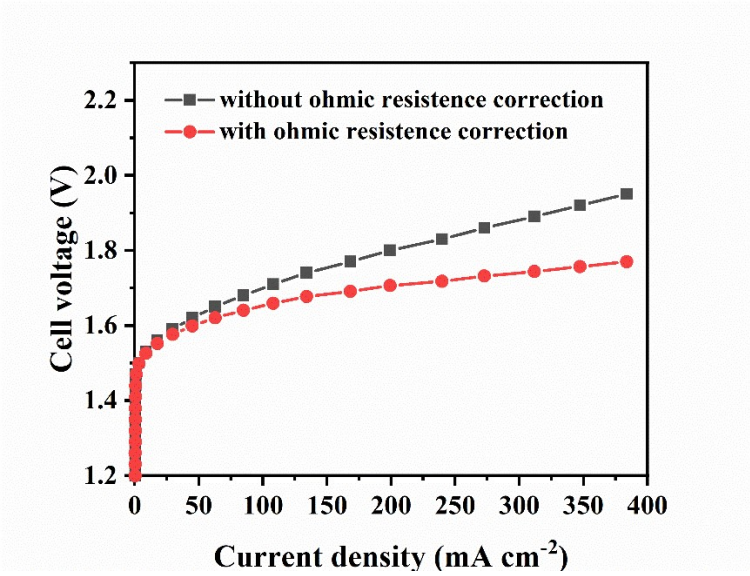

Fig. S9 Polarization curves of the PEM electrolysers using UF-Ir/IrO_x as anode and Pt/C as cathode at 25°C.

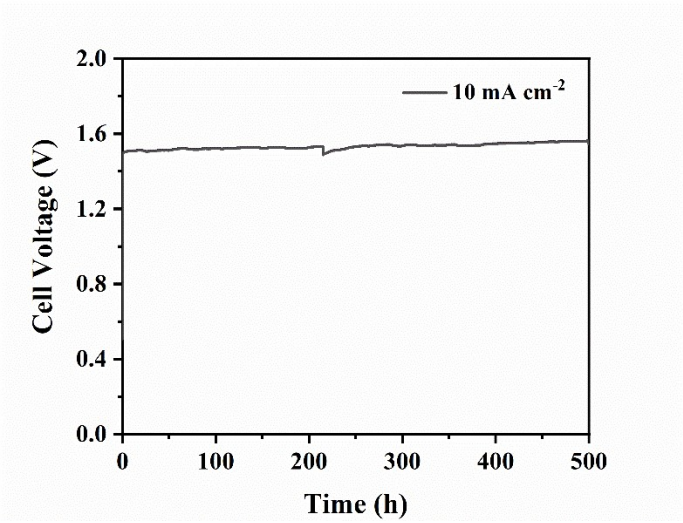

Fig. S10 Chronopotentiometry curve of the PEM electrolyzer using UF-Ir/IrO_x operated at 10 mA cm^{-2}.

Table S1. Content of organic elements in UF-Ir/IrO_x.

Elements	**C**	**H**
Content	**7.19%**	**2.26%**

Table S2. The OER activity of Ir/IrO_x reported in literatures.

Catalyst	η@10 mA cm^{-2}(mV)	j_m(@=1.53 V vs. RHE) (A g_{Ir}^{-1})	Ref
UF-Ir/IrO_x	299	132	This work
IrO_2 NPs	370	30	J. Phys. Chem. Lett. 2012, 3, 399
$IrO_x/Lu_2Ir_2O_7$	301	78(@1.525 V_{RHE})	ACS Appl. Mater. Interfaces 2021, 13, 29654
IrO_2 nanospheres	352	58(@1.51 V_{RHE})	ACS Appl. Nano Mater. 2022, 5, 3, 4062
IrO_x-Ir	-	8.1(@1.48 V_{RHE})	Angew. Chemie 2016, 128 (2), 752
H_xIrO_3 nanosheet	277	120(@1.58 V_{RHE})	ACS Appl. Energy Mater. 2022, 5, 6, 6869
IrO_2 nanoneedles	313	52(@1.55 V_{RHE})	Adv. Funct. Mater. 2018,28(4),7
Ir atomic cluster/IrO_2 nanoneedles	308	62(@1.55 V_{RHE})	Journal of Power Sources 2022, 524, 7.
IrO_2 NPs/TiO_2	-	59	Appl. Mater. Today 2021, 24, 15.