

Supporting information

**Ruthenium Nanoparticles Supported on S-doped Graphene
as an Efficient HER Electrocatalyst**

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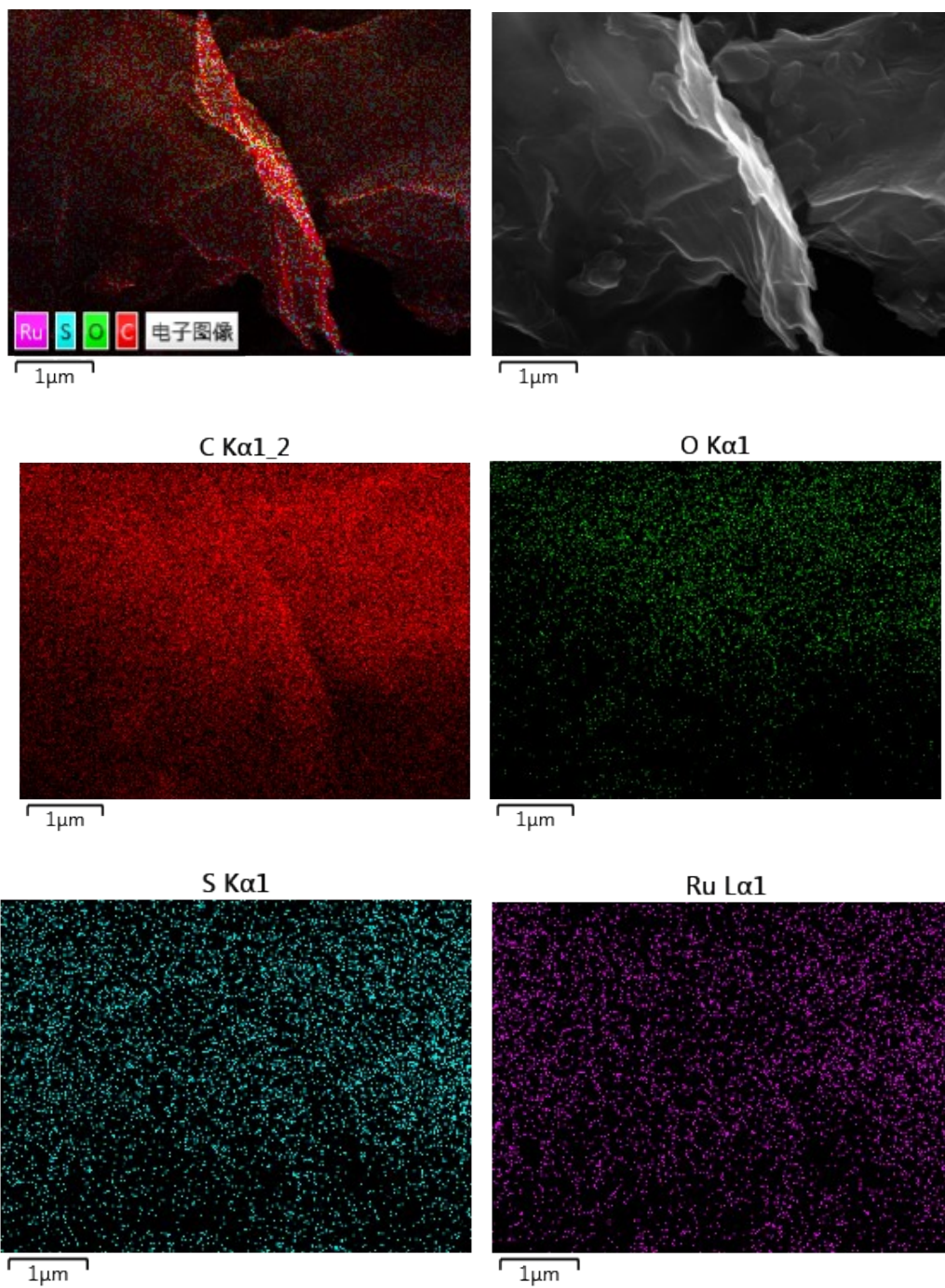


Fig. S1 EDS mapping of Ru@SGO

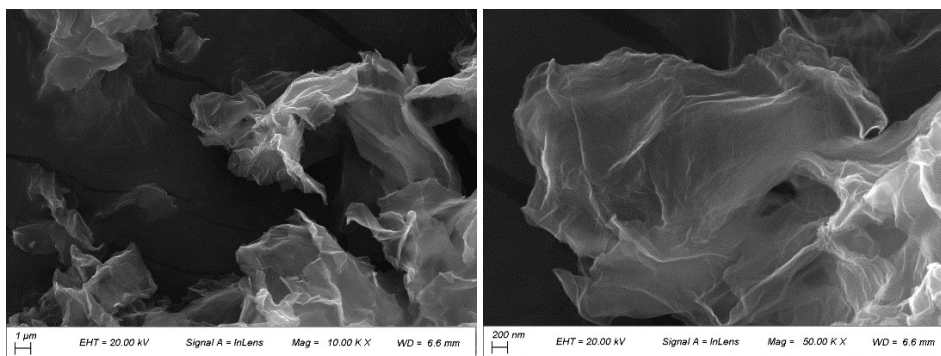


Fig. S2 SEM of Ru@GO

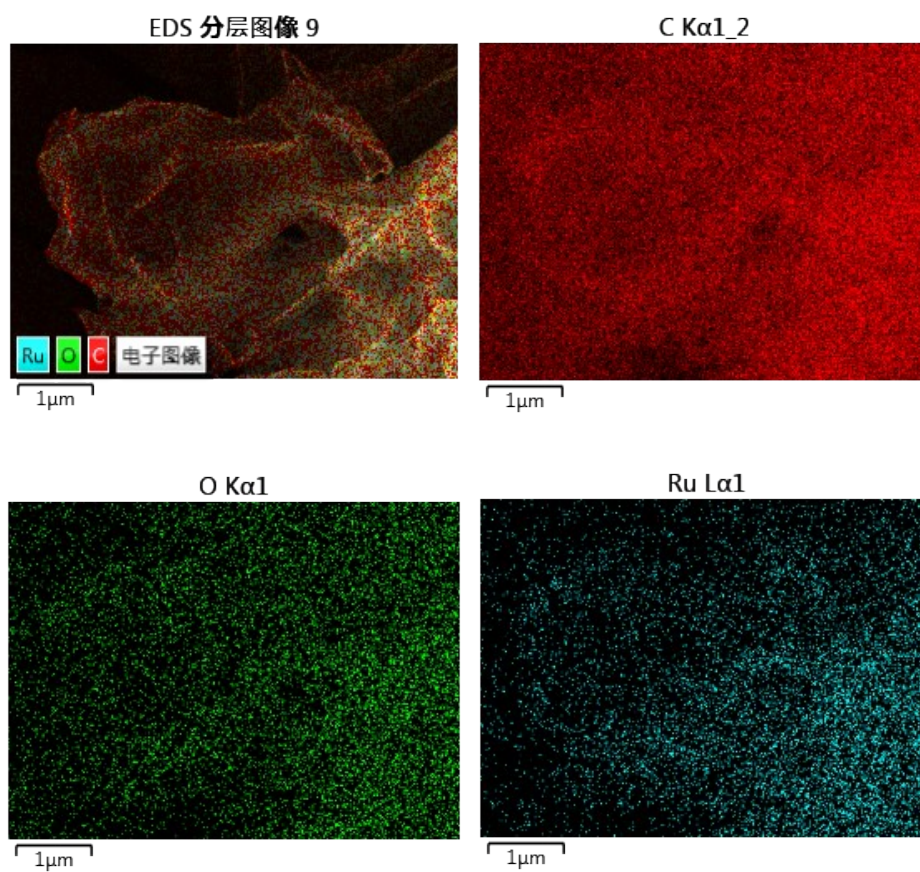


Fig. S3 EDS mapping of Ru@GO

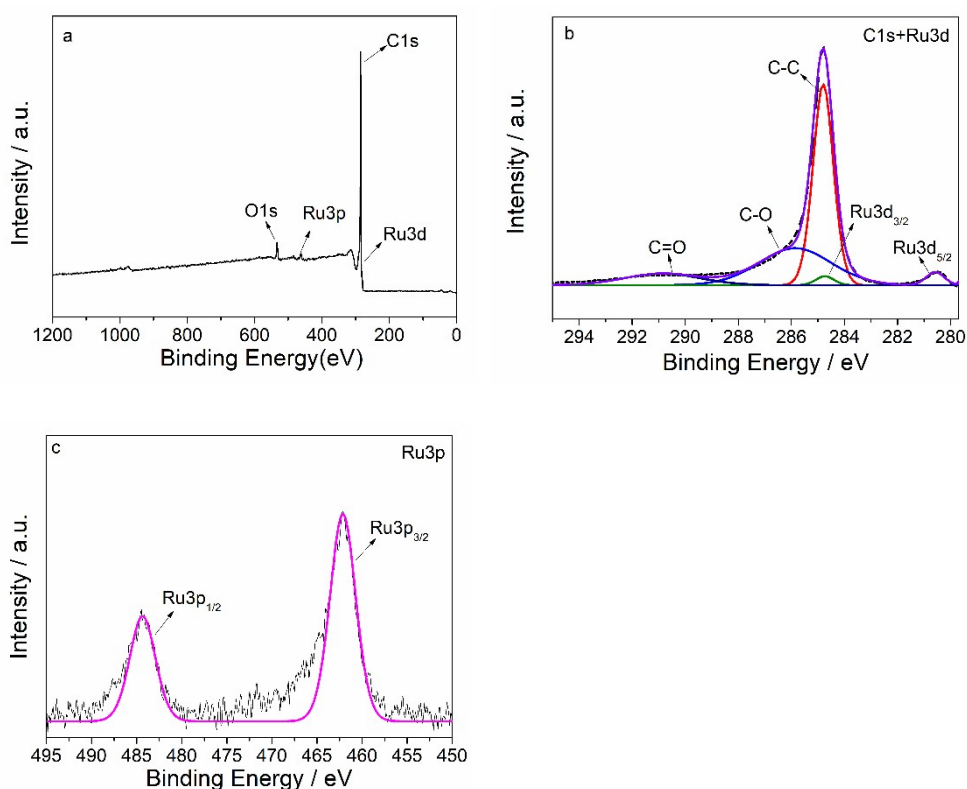


Fig. S4 (a) XPS survey spectra of Ru@GO, (b-c) high-resolution XPS spectra of C1s+Ru3d, Ru3p.

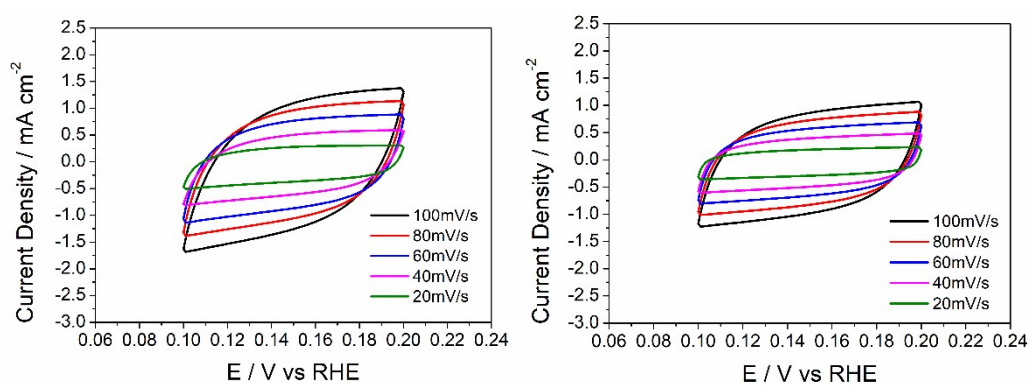


Fig. S5 CV curves of Ru@GO at various scan rates, (left) 1 M KOH, (right) 0.5 M H₂SO₄

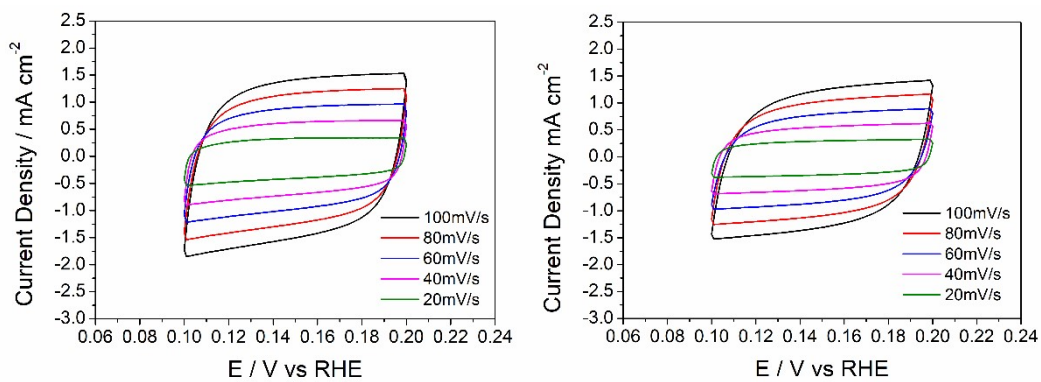


Fig. S6 CV curves of Ru@SGO at various scan rates, (left) 1 M KOH, (right) 0.5 M H₂SO₄

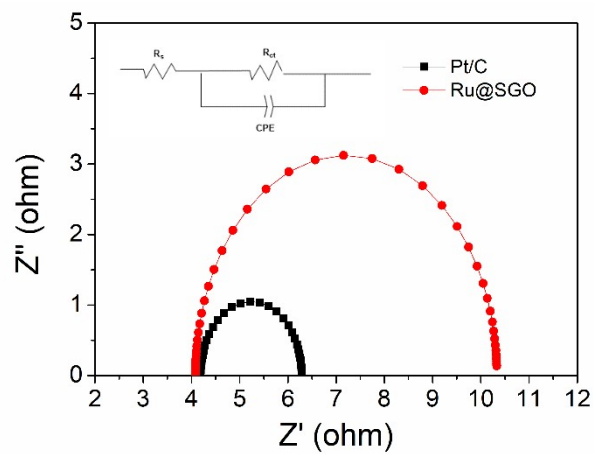


Fig. S7 EIS of Ru@SGO and Pt/C in 1 M KOH.

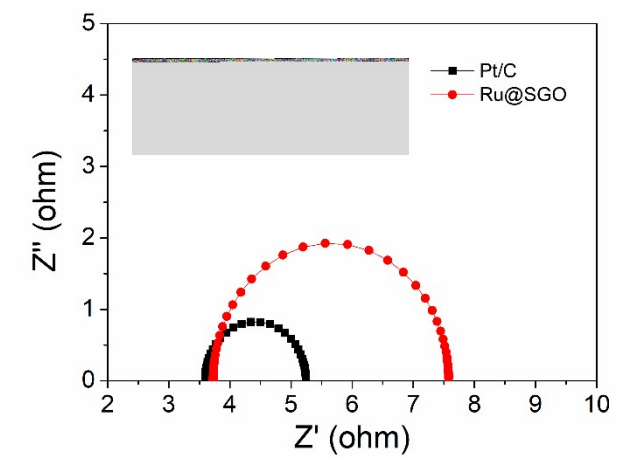


Fig. S8 EIS of Ru@SGO and Pt/C in 0.5 M H₂SO₄.

Table S1. HER catalytic activities of Ru@SGO and some other catalysts reported in recent literatures (at 10 mA cm⁻² for HER in 0.5 M H₂SO₄).

Catalysts	HER Overpotential @10 mA cm ⁻² (mV)	Tafel Slope (mV dec ⁻¹)	Ref.
Ru@SGO	69	52	In this work
CoWP-CA/KB	111	58	ACS Sustainable Chem. Eng., 2021, 9, 36, 12311-12322.
CoSAs/PTF-600	94	50	J. Mater. Chem., A, 2019, 7, 1252.
MoS ₂ -60s	131	48	J. Am. Chem. Soc., 2020, 142, 4298.
s-RuS ₂ /S-rGO	69	64	ACS Appl. Mater. Interfaces, 2018, 10, 34098.
L-Ag	136	71	Nature Catalysis, 2020, 2, 1107.
RuP ₂ /1.03CDs-900	100	61	ACS Sustainable Chem. Eng., 2020, 8, 3995–4002.
Ni-WP2 NS/CC	110	65	Journal of Energy Chemistry, 2021, 55, 17-24.
WC1-X	247	/	ACS Appl. Energy Mater., 2020, 3, 1082.
ZnCo/NC@MoS ₂	130	60	Electrochim. Acta, 2020, 331, 135445-135454.
B12/G800A	115	65	J. Mater. Chem. A, 2019, 7, 7179.
Mo-W-P/CB	165	63	J. Coord. Chem., 2020, 73, 2590-2601.
FePc-MoS ₂	123	32	Nanoscale, 2019, 11, 14266.
Pd/Nb ₂ C-HF	34	34	Catal. Today, 2021, 368, 187-195.
Pt-MXene-CNTs	62	78	Adv. Funct. Mater., 2020, 30, 2000693.
S-Doped MoP Nanoporous Layer	117	34	ACS Catal., 2019, 9, 651.
Pd ₃₅ Pt ₁₉ Cu ₄₆ /Ti ₂ CTx-CNT	4	18	J. Mater. Chem. A, 2021, 9, 23085-23094.
CrB ₂	355	78	Inorg. Chem. Front., 2021, DOI:10.1039/D1QI00496D.

Table S2. HER catalytic activities of Ru@SGO and some other catalysts reported in recent literatures (at 10 mA cm⁻² for HER in 1 M KOH).

Catalysts	HER Overpotential @10 mA cm ⁻² (mV)	Tafel Slope (mV dec ⁻¹)	Ref.
Ru@SGO	33	56	In this work
MoP@NCHSs	92	62	Angew. Chem. Int. Ed., 2019, 58, 2.
NiFe-LDH-Co ₃ O ₄ /NF	162	105	Chem. Eur. J., 2021, 27, 3367-3373.
MoS ₂ /CoNi ₂ S ₄	78	67	Adv. Funct. Mater., 2020, 30, 1908520.
Co ₃ S ₄ @FNC-Co ₃	140	103	Carbon, 2020, 160, 133.
MoS ₂ /NiS	244	97	Small, 2019, 15, 1803639.
Ru-NiFeP/NF	56	/	Applied Surface Science, 2021, 536, 147952.
Fe _{1.0} CO _{1.1} Ni _{1.4} -NC	175	76	J. Mater. Chem. A, 2020, 8, 9021-9031.
Ru ₁ Co ₂ NP	188	/	ACS Applied Energy Materials, 2020, 3, 1869-1874.
Rh-Rh ₂ P@C	37	32	J. Mater. Chem. A, 2020, 8, 12378.
MoPS	158	52	Appl. Catal. B-Environ., 2019, 245 656.
MoS ₂ -Mo ₂ C/Mo	56	/	Chem. Commun., 2021, DOI:10.1039/D1CC04431A.
RuP ₂ @PC	79	37	J. Mater. Chem. A, 2021, 9, 12276-12282.
FF-NaCl-Ir-P	69	/	J. Mater. Chem. A, 2021, 9, 12074-12079.
Co-Mo-P/Co-Zn-S	120	62	Nanoscale, 2021, DOI:10.1039/D1NR04374A.
Ru/NiFe LDH-F/NF	116	/	Applied Surface Science, 2020, 528, 146972.
Ru/PEI-XC	13	/	J. Mater. Chem. A, 2021, 9, 22934-22942.