Supporting Information for

Revealing and Magnifying Interfacial Effects between Ruthenium and Carbon Supports for Efficient Hydrogen Evolution

Yongjun Jiang[1], Ting-Wei Huang[2], Hsuan-Lien Chou[2], Lihui Zhou[1],

Sheng-Wei Lee[2], Kuan-Wen Wang[2,3,] *, Sheng Dai[1,]*

[1] Key Laboratory for Advanced Materials and Joint International Research Laboratory of Precision Chemistry and Molecular Engineering, Feringa Nobel Prize Scientist Joint Research Centre, Frontiers Science Center for Materiobiology and Dynamic Chemistry, Institute of Fine Chemicals, School of Chemistry and Molecular Engineering, East China University of Science & Technology, Shanghai 200237, China

[2] Institute of Materials Science and Engineering, National Central University, Taoyuan 320, Taiwan

[3] Department of Materials Science and Engineering, National Taiwan University of Science and Technology, Taipei 10607, Taiwan

* Corresponding Authors: kuanwen.wang@gmail.com (K.-W.W.)

shengdai@ecust.edu.cn (S. D.)

Table S1. Surface compositions of various Ru catalysts characterized by XPS.

Sample	Surface composition (at%)						Ru composition (%)	
	C	O	N	Ru	Zn	S	Ru^0	Ru^{4+}
Ru/AC	75.0	14.2	0.3	10.5	-	-	31.1	60.9
Ru/PC	73.5	12.3	2.4	11.1	0.1	0.6	48.5	51.5
Ru/ZC	76.8	10.1	2.0	11.0	0.1	-	77.2	22.8

Table S2. Fitting results of the Raman spectra with Gaussian-Lorentzian peaks.

Sample	P (%)	D (%)	A (%)	G (%)	I_D/I_G
Ru/AC	1.0	62.2	11.4	25.4	1.2
Ru/PC	2.0	44.5	46.5	7.0	3.4
Ru/ZC	7.3	53.6	27.1	12.0	2.2

Table S3. Structure parameters of various Ru catalysts from EXAFS fitting.

Sample	Ru K-edge		
	Bond pair	CN[a]	R (Å)
Ru/AC	Ru-C	1.97	2.089
	Ru-O	2.05	1.995
	Ru-Ru	4.71	2.678
Ru/PC	Ru-C	1.87	2.089
	Ru-O	2.09	1.995
	Ru-Ru	3.61	2.677
Ru/ZC	Ru-C	2.26	2.061
	Ru-Ru	2.82	2.651

[a] coordination number

Table S4. The HER performance of Ru/C catalysts in 1.0 M KOH.

Sample	ECSA(m^2/g)	Overpotential (mV)		Tafel Slope (mV/dec)	
		Initial	After ADT	Initial	After ADT
Ru/AC	32	109	122	136	179
Ru/PC	83	72	82	114	147
Ru/ZC	128	38	49	110	115
Ru/ZC-E50	130	29	35	82	92
Ru/ZC-E100	110	36	39	92	95

Table S5. Ru contents in both electrolytes and catalysts for initial Ru/ZC, Ru/ZC-E50, and Ru/ZC-E100.

	Ru Content (wt%)	
	Electrolytes	**Catalysts**
Ru/ZC	/	4.0
Ru/ZC-E50	0.1	3.9
Ru/ZC-E100	0.3	3.7

Table S6. Comparison of recently reported Ru catalysts in 1.0 M KOH.

Catalyst	η_{10} (mV)	Tafel slope (mV/dec)	Stability			Ref.
			Decay of η_{10} (mV)	Decay of [a] j (%)	Duration	
Ru/ZC	38	110	11		5k cycles	This work
Ru/ZC-E50	29	82	6	-	5k cycles	
Ru-CN-RGO	45	40	5	-	15 hours	40
Ru@NG-4	40	76	-	5	5k cycles	41
RuSAs-Ni_2P	57	75	-	-	2k cycles	42
Ni@Ru/CNS-10%	20	87	8	-	3k cycles	43
Ru-ZIF-900	52	78	-	4	8 hours	27
Ru@WNO-C	24	40	46	-	10k cycles	44
Ru@Co-NC-800	23	58	-	10	10 hours	28
Ru/rGO-V	60	40	-	-	-	45
Ru-Cr_2O_3/NG	47	39	-	-	20k cycles	46
P-Ru/C	31	105	-	-	1k cycles	29
Ru_3@NCF	181	73	-	6	8.3 hours	47

[a] ***j*: current density.**

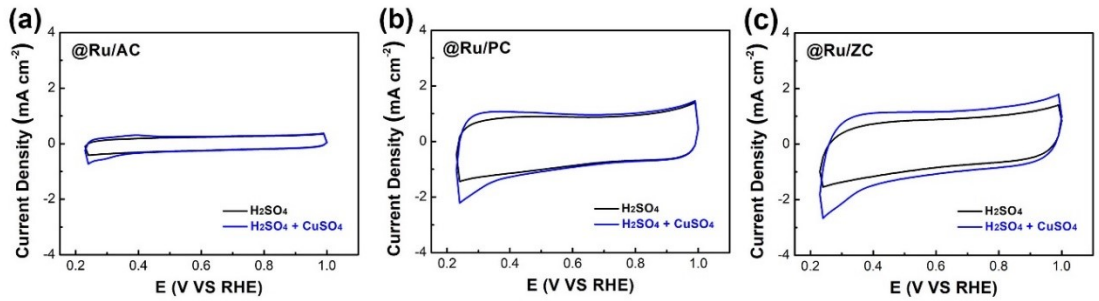

Figure S1. Cu_{UPD} scanning curves of Ru/AC, Ru/PC, and Ru/ZC.

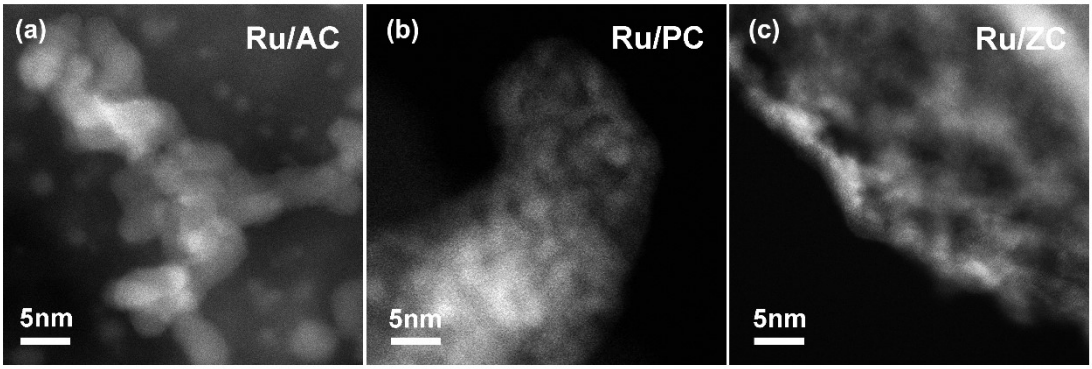

Figure S2. HAADF-STEM images of Ru/AC, Ru/PC, and Ru/ZC after ADT.

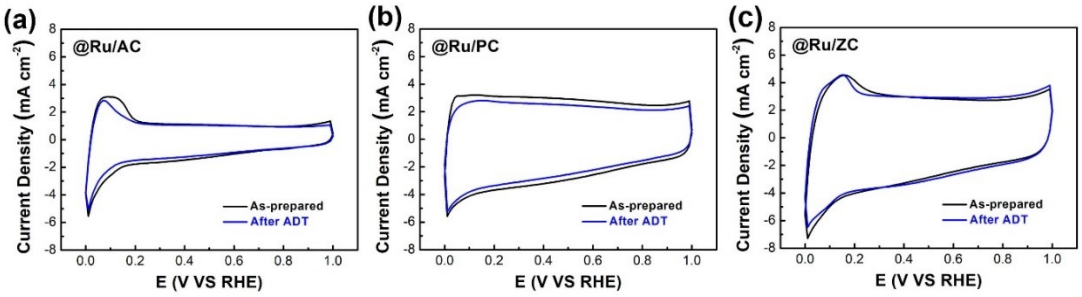

Figure S3. CV curves before and after ADT for Ru/AC, Ru/PC, and Ru/ZC.

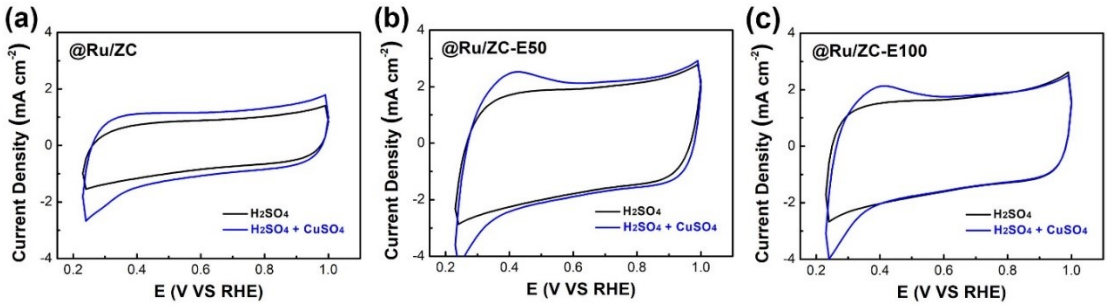

Figure S4. Cu_{UPD} scanning curves of Ru/ZC, Ru/ZC-50, and Ru/ZC-100.

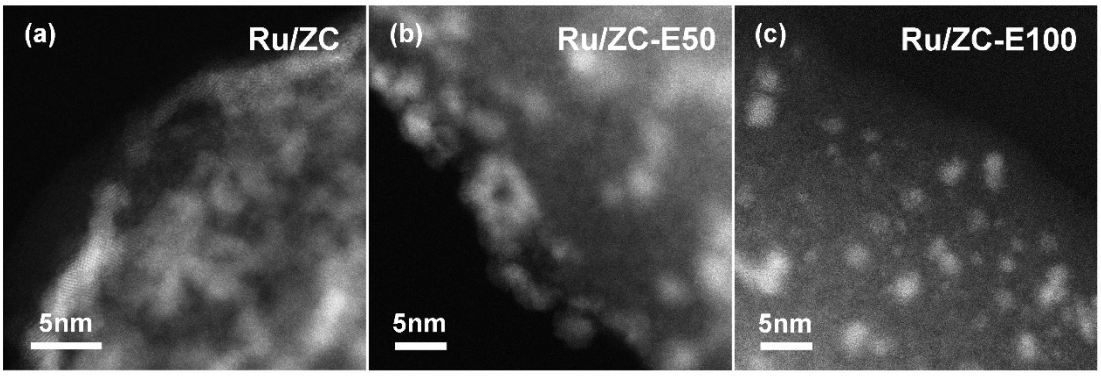

Figure S5. HAADF-STEM images of Ru/ZC, Ru/ZC-E50, and Ru/ZC-E100 after ADT.

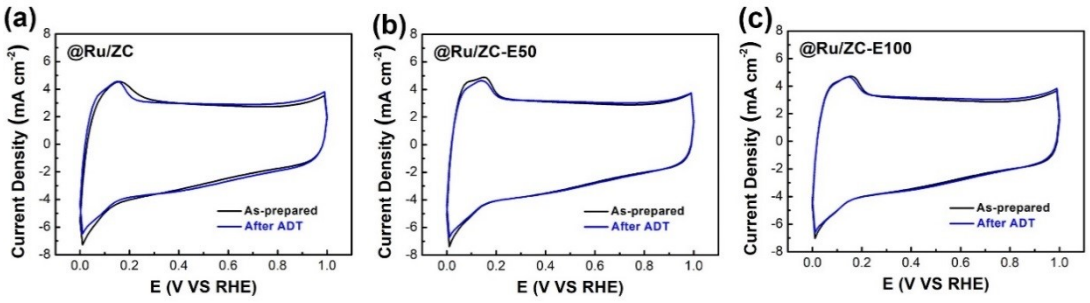

Figure S6. CV curves before and after ADT for Ru/ZC, Ru/ZC-E50, and Ru/ZC-E100.