

CORRECTION

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Correction: Covalent organic and metal organic frameworks based single atom catalysts for valorisation of CO₂ to value added chemicals

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The references cited in Tables 2 and 3 were incorrect. These tables should appear as here.

The Royal Society of Chemistry apologises for these errors and any consequent inconvenience to authors and readers.

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Table 2 The key factors influencing CO₂ reduction reaction (CO₂RR) performance to achieve high selectivity and efficiency

Electrocatalyst	Electrolyte	Potential (V)	Product	FE (%)	Ref.
M-N ₄ SAC					
Ni SAs/N-C	0.5 M KHCO ₃	-0.89	CO	71.9	154
C-AFC@ZIF-8 (Fe-N)	1.0 M KHCO ₃	-0.43	CO	93%	155
Fe-N-C	0.5 M NaHCO ₃	-0.6	CO	90	156
SE-Ni SAs@PNC	0.5 M KHCO ₃	-0.7 to 1.2	CO	90	157
Fe-N ₂₊₂ -C ₈	0.5 M KHCO ₃	-0.58	CO	93	158
Cu-N ₄ C ₈	0.1 M KHCO ₃	-0.8	CO	96	159
Co-N ₄	0.1 M KHCO ₃	-0.8	CO	82	160
Ni SAs/NCNTs	0.5 M KHCO ₃	-0.9	CO	97	161
Ni-N-C	0.5 M KHCO ₃	-0.8	CO	96.8	162
Ni-N-C	0.5 M KHCO ₃	-0.66 to -0.96	CO	100	163
Fe-N ₄	0.1 M KHCO ₃	-0.8	CO	90	164
Cu-N ₄ -C/1100	0.1 M KHCO ₃	-0.9	CO	98	165
Fe-N-C900	0.1 M KHCO ₃	-1.2V (V Ag/AgCl)	CO	86.8	166
Fe-N-C-1000	0.5 M KHCO ₃	-0.9	CO	100	167
Ni-N/C@900	0.1 M KHCO ₃	-0.76	CO	90	168
M-Ni-N-C-2/CNTs	0.1 M KHCO ₃	-0.7	CO	98	169
Pyrolic vs. pyridinic					
Ni SAC-1000	0.5 M KHCO ₃	-0.8	CO	98.2	170
Cu-SA/NPC	0.1 M KHCO ₃	-0.36	CH ₃ COCH ₃	36.7	171
Fe ³⁺ -N-C	0.5 M KHCO ₃	-0.2	CO	> 80	172
Ni-N ₃ -C	0.5 M KHCO ₃	-0.75	CO	99.37	173
Ni-N _{pyrolic} -C	0.5 M KHCO ₃	-0.85 V	CO	92	174
Low-coordinate SACs					
C-Zn ₁ Ni ₄ ZIF-8	1 M KHCO ₃	-0.83	CO	98	175
Co-N ₂	0.5 M KHCO ₃	-0.68	CO	94	176
Cu-N-C-900	0.1 M KHCO ₃	-1.6	CH ₄	38.6	177
NiSA-N ₂ -C	0.5 M KHCO ₃	-0.8	CO	98	89
Ni-N ₃ -C	0.5 M KHCO ₃	-0.65	CO	95.6	178
MS-L-Ni-NC (Ni-N ₃ -C)	0.5 M KHCO ₃	-0.8	CO	98.7	179
Fe/Ni-N-C	0.5 M KHCO ₃	-0.677	CO	92.9	180
Ni-NC-NS (Ni-N ₂ -C)	0.5 M KHCO ₃	-1.0	CO	86	181
Ni-N ₃ /NC	0.1 M KHCO ₃	-1.3	CO	94.6	182
Axially coordinated SACs					
Fe-SA/ZIF (Fe-N ₅)	0.1 M KHCO ₃	-0.7	CO	98	183
Ni-N ₄ -O/C	0.5 M KHCO ₃	-0.9	CO	100	184
Carbon coordinated SACs					
Co-N ₂ -C ₃	0.1 M KHCO ₃	-0.8	CO	92	185
Co-C ₂ N ₂	0.1 M KHCO ₃	-0.8	CO		186
Ni-N ₁ -C ₃	0.5 M KHCO ₃	-0.9	CO	97	187
Oxygen coordinated SACs					
Fe ₁ N ₂ O ₂ /NC	0.1 M KHCO ₃	-0.5	CO	99.7	188
FeN ₂ O ₂ /NC	0.5 M KHCO ₃	-0.7	CO	95.5	189
Sulphur coordinated SACs					
Co-S ₁ N ₃	0.5 M KHCO ₃	-0.5	CO	98	190
MnN ₃ S ₁	0.5 M KHCO ₃	-0.45	CO	70	191
Ni-NSC	0.5 M KHCO ₃	-1.035	CO	98	192
Phosphorous coordinated SACs					
Ni-SA/CN-P	0.5 M KHCO ₃	-0.8	CO	96.9	193
Ni-P ₁ N ₃	0.5 M KHCO ₃	-0.75	CO	98	194
Halogen coordinated SACs					
Ni ₁ -N-C (Cl)	0.5 M KHCO ₃	-0.7	CO	94.7	196
Ni ₄ Cl-ClNC	0.5 M KHCO ₃	-0.7	CO	98.7	197
Ni-NBr-C	0.5 M KHCO ₃	-0.7	CO	97	198
FeN ₄ Cl/NC	0.5 M KHCO ₃	-0.6	CO	90.5	199
P-block metal SACs					
In ^{δ+} -N ₄	0.5 M KHCO ₃	-0.95	HCOOH	96	200
In-N-C	0.5 M KHCO ₃	-0.99	HCOOH	80	201
InA/NC	0.5 M KHCO ₃	-2.1 vs Ag/Ag ⁺	CO	97.2	202
In-SAC-1000	0.5 M KHCO ₃	-0.6	CO	97	203
Bi SAs/NC	0.1 M NaHCO ₃	-0.5	CO	97	204
Al-NC	0.1 M KHCO ₃	-0.65	CO	98.76	205
SnN ₃ O ₁	0.1 M KHCO ₃	-0.7	CO	94	206
Hetero-metal SACs					
NiCu-SACs/N-C	0.5 M KHCO ₃	-0.6	CO	92.2	207
Co _{0.5} Ni _{0.5} -N-C	0.5 M KHCO ₃	-0.5 to -1.1	CO	50 ± 5	208
Ni-Al NC	0.1 M KHCO ₃	-0.8	CO	98	209
Cu-In-NC	0.1 M KHCO ₃	-0.7	CO	96	210
Ni/Fe-N-C	0.5 M KHCO ₃	-0.7	CO	98	211
NiN ₃ @CoN ₃ -NC	0.1 M KHCO ₃	-1.1	CO	97.7	212



Table 2 (continued)

Electrocatalyst	Electrolyte	Potential (V)	Product	FE (%)	Ref.
Ni/Cu-N ₆ -C	0.5 M KHCO ₃	-0.6	CO	97.7	213
Ni-N ₃ /Cu-N ₃	0.5 M KHCO ₃	-1.1	CO	99.1	214
Cu-Fe-N ₆ -C	0.1 M KHCO ₃	-0.7	CO	98	215
Fe/Cu-N-C	0.1 M KHCO ₃	-0.8	CO	99.2	216
O-Ni ₂ -N ₆	1.0 M KHCO ₃	-1.25	CO	94.3	217
Fe ₂ -N ₆ -C-o	0.5 M KHCO ₃	-0.8	CO	95.85	218
Fe ₂ N ₆	0.1 M KHCO ₃	-0.6	CO	96	219
CuNi-DSA/CNFs	0.1 M KHCO ₃	-0.98	CO	99.6	220
InNi DS/NC (O-In-N ₆ -Ni)	0.5 M KHCO ₃	-0.7	CO	96.7	124
Fe ₁ -Ni ₁ -N-C	0.5 M KHCO ₃	-0.5	CO	96.2	221
Others					
Ni-NPIC4	0.5 M KHCO ₃	-0.65	CO	95.1	222
Ni ₁ -N-C-50	0.5 M KHCO ₃	-0.7	CO	96	223
Ni _x -N-C	0.5 M KHCO ₃	-0.7	CO	80	224
Ni _{Mn} -N-C	0.5 M KHCO ₃	-0.72	CO	98.5	225
FeSAs/CNF-900	0.5 M KHCO ₃	-0.47	CO	86.9	226
CHK-cOCTA	0.1 M KHCO ₃	-1.5	CH ₄	54.8	227
Ni/HH	0.5 M KHCO ₃	-0.77	CO	97.9	228
Ni-NG-acid	0.5 M KHCO ₃	-0.9	CO	97	229
mesoNC-Fe	0.1 M KHCO ₃	-0.73	CO	85	230
Ni/NCTs	0.5 M KHCO ₃	-0.8	CO	100	232
Ni-NC ₃ @Cu ₂ O	1.0 M KOH	-1.2	C ₂ H ₄ C ₂ H ₅ OH CH ₃ COOH	60	233
Ni SACs-Cu NPs	1.0 M KOH	-0.7	C ₂ H ₄ C ₂ H ₅ OH CH ₃ COOH	80	234
P-NiSA/PCFM	0.5 M KHCO ₃	-0.7	CO	96	235
CuSAs/TCNFs	0.1 M KHCO ₃	-0.9	CH ₃ OH	44	236
Ni-PCNFs	0.1 M KHCO ₃	-1.5	CO	98.6	237
Zn-SA/CNCl-1000	1.0 M KOH	-0.93	CO	97	238
Ni/Zn-6	0.1 M KHCO ₃	-1.0	CO	94	239



Table 3 Top publications of CO₂ valorisation used in electrochemical, photoelectrochemical, and thermal processes

Electrocatalyst	Electrolyte	Product	FE (%)	Potential (V)	Turn over frequencies (TOF-h ⁻¹)	Current density (mA cm ⁻²)	Ref.
A-Ni-NSG	0.5 M KHCO ₃	CO	97%	0.61	14 800	22.0	137
Ni-N-C	0.5 M KHCO ₃	CO	96.8	-0.80	11 315	27.0	162
Fe ³⁺ -N-C	0.5 M KHCO ₃	CO	> 80	-0.20	~ 1100	94.0	172
C-Zn ₁ Ni ₄ ZIF-8	1 M KHCO ₃	CO	98	-0.83	10 087	44.1	175
Ni-NBr-C	0.5 M KHCO ₃	CO	97	-0.70	35 289.7	350	198
InA/NC	0.5 M KHCO ₃	CO	97.2	-2.10	~ 40 000	39.4	202
Al-NC	0.1 M KHCO ₃	CO	98.76	-0.65	12 960	330	205
Ni/Cu-N ₆ -C	0.5 M KHCO ₃	CO	97.7	-0.60	20 695	> 100	213
Ni-N ₃ /Cu-N ₃	0.5 M KHCO ₃	CO	99.1	-1.10	22 304	88.0	214
Zn-SA/CNCl-1000	1.0 M KOH	CO	97	-0.93	29 325	271.7	238

Photocatalytic	Condition	Light	Product	Selectivity (%)	TOF or TON	Yield	Ref.
Ni-TpBpy	(Acetonitrile, pure water, triethanolamine)	300 W Xe lamp	CO	96 (5 h)	13.62 (5 h)	4057 μmol g ⁻¹	246
Tpy-COF-Co	(Acetonitrile, deionized water, triethanolamine)	300 W Xe lamp	CO	—	(TOF) 1607 h ⁻¹ and TON 2095	426 mmol g ⁻¹ h ⁻¹	247
Co ₁ Cu ₁ /NC	(Acetonitrile, pure water, triisopropanolamine)	300 W Xe lamp	CO	83.40 (2 h)	59	22.46 mmol g ⁻¹	250
Co _{SA} -N _x /C	(Acetonitrile, pure water, triisopropanolamine)	300 W Xe lamp	CO	82.60	98 (2 h)	10 110 μmol g ⁻¹ h ⁻¹	251
Fe-NO/NC	(Acetonitrile, deionized water, triethanolamine)	300 W Xe lamp	CO	86.70	1494 (1 h)	81.8 μmol	252
Co-COF	(Acetonitrile, [Ru(bpy) ₃ Cl ₂]·6H ₂ O, TEOA)	300W Xe lamp	CO	95.70	(TOF) 111.8 h ⁻¹	18 000 μmol g ⁻¹ h ⁻¹	255
Fe SAS@Tr-COF	(Acetonitrile, water, [Ru(bpy) ₃ Cl ₂]·6H ₂ O, TEOA)	300 W Xe lamp	CO	96.40	2.89	980.3 μmol g ⁻¹ h ⁻¹	51
Cu-SA/CTF	(Triethanolamine, water)	300 W Xe lamp	CH ₄	98.31	24.05 (4 h)	32.56 μmol g ⁻¹ h ⁻¹	256
TCM-Bpy-COF-CoAC	(Acetonitrile, water, [Ru(bpy) ₃ Cl ₂]·6H ₂ O, TEOA)	5 W LED (λ = 400–800 nm)	CO	81.80	—	26 650 μmol g ⁻¹ h ⁻¹	257
Pt-SA/CTF-1	(triethanolamine, water)	300W Xe lamp	CH ₄	76.60	—	—	258
Fe@MIL-OV-300	(Triethylamine, acetonitrile, water)	300 W Xe lamp	CH ₃ OH	—	(TOF) 16.03 h ⁻¹	15.85 mmol g ⁻¹ at 4 h	259
NiSAs@NPs/TC	(Deionized water, CO ₂ gas)	300 W Xe lamp	CO, CH ₄	—	—	35.60 and 3.41 μmol g ⁻¹ h ⁻¹	260

Thermocatalytic	Condition	Temperature	Product	Selectivity (%)	TOF or TON	Yield	Ref.
Co-N-C							
20% Co-N-C	Mixed gas (H ₂ /CO ₂ /N ₂)	500 °C	CO	~ 100	73 h ⁻¹	37.5 mol kg ⁻¹ h ⁻¹	261
			CH ₄	99.3		33.6 mol kg ⁻¹ h ⁻¹	
NU-1000-NH ₂ /PrS-Cu	CO ₂ and 3.H ₂	280 °C	CH ₃ OH	100	—	100 mg MeOH gcac ⁻¹ h ⁻¹	272

