Energy & Environmental Science

ROYAL SOCIETY OF CHEMISTRY

CORRECTION

View Article Online
View Journal

Cite this: DOI: 10.1039/d5ee90091c

Correction: Covalent organic and metal organic frameworks based single atom catalysts for valorisation of CO_2 to value added chemicals

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DOI: 10.1039/d5ee90091c

rsc.li/ees

Correction for 'Covalent organic and metal organic frameworks based single atom catalysts for valorisation of CO_2 to value added chemicals' by Sowjanya Vallem *et al.*, *Energy Environ. Sci.*, 2025, https://doi.org/10.1039/d5ee02702k.

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 CO_2 reduction reaction (CO_2RR) 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_4C_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
Pyrrolic *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_3COCH_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–$N_{Pyrrolic}$–C	0.5 M $KHCO_3$	−0.85 V	CO	92	174
Low-coordinate SACs					
C-Zn_1Ni_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–N5)	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_2N_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					
$Fe_1N_2O_2$/NC	0.1 M $KHCO_3$	−0.5	CO	99.7	188
FeN_2O_2/NC	0.5 M $KHCO_3$	−0.7	CO	95.5	189
Sulphur coordinated SACs					
Co–S_1N_3	0.5 M $KHCO_3$	−0.5	CO	98	190
MnN_3S_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_1N_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
NiN_4Cl–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_4Cl/NC	0.5 M $KHCO_3$	−0.6	CO	90.5	199
P-block metal SACs					
$In^{\delta+}$–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_3O_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_2N_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_2O	1.0 M KOH	−1.2	C_2H_4 C_2H_5OH CH_3COOH	60	233
Ni SACs-Cu NPs	1.0 M KOH	−0.7	C_2H_4 C_2H_5OH CH_3COOH	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_3OH	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 CO_2 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_1Ni_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_1Cu_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, $[Ru(bpy)_3Cl_2]\cdot 6H_2O$, 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, $[Ru(bpy)_3Cl_2]\cdot 6H_2O$, 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, $[Ru(bpy)_3Cl_2]\cdot 6H_2O$, 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_3OH	—	(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_3OH	100	—	100 mg MeOH $gcat^{-1}$ h^{-1}	272