Electronic Supplementary Information

Copper-Alloy Catalysts: Structural Characterizations and Catalytic Synergies

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Table 1 Summary of Selected Examples of Copper-Alloy Catalysts in Terms of Methods, Structures and Reactions

Catalyst	Method	Morphology & Surface Composition	Catalytic reaction/mechanism	ref.
Au_nCu_{100-n}	Wet chemical reduction	Nanocubes (AuCu nanoparticles)	CO oxid/ Melting−resolidification	1
AuCu	Co-deposition	Metallic films (AuCu alloy)	CO_2RR/ D-band center shifts	2
Fcc-AuCu	Seed-mediated	Nanoparticles (Fcc-AuCu alloy→ CuO)	CO oxid/ Mars−van Krevelen	3
Fct-AuCu	Seed-mediated	Nanoparticles (Fct-AuCu alloy→ CuO)	CO oxid/ Mars−van Krevelen	3
AuCu	Wet chemical	Nanoparticles (Cu, Au)	CO_2RR/ Three atomic gold layers	4
Au thin layer on Cu	Galvanic displacement	Lamella structure (Au-Cu alloy, Cu)	CO_2RR/ Au thin layer	5
$Pt_{32}Cu_{68}$	Wet chemical	Nanowires (PtCu alloy)	CH_3OH Oxid/ PtCu nanowires site	6
Pt-Cu single -atom	Galvanic replacement	Nanoparticles (Pt, Cu)	CO oxid/ Pt-Cu single-atom alloy	7
Pt-Ni-Cu	Wet chemical	Nanoparticles (Pt, Ni, Cu)	ORR/ Extra bi-functional	8
Pd_nCu_{100-n}	Wet chemical	Spherical particles (Pd–Cu alloy, Cu_xO)	CO oxid/ Catalytic synergy	9
PdCu/C	Wet chemical	Nanoparticles (Cu^0, Cu^{2+}, Pd^0, Pd^{2+})	ORR/ Nanostructural tuning	10
Pd_nCu_{100-n}	Wet chemical reduction	Nanoparticles (PdCu alloy)	CO oxid/ Langmuir−Hinshelwood	11
Pd-Cu	Co-impregnation	Nanoparticles (PdCu alloy phase)	CO_2 to CH_3OH/ H-shuttled	12
Pd/Cu(111)	--	Layer (Pd, Cu)	DOM/ Isolated Pd in Cu surface	13
Pd_xCu_1-TiO_2	Wet chemical	PdCu nanocrystal (Pd^0, Cu^0)	CO_2 to CH_4/ Paired Cu−Pd sites	14
Cu-Pd	Colloidal synthesis	Spherical (Cu-Pd nanoparticles)	CO_2RR/ Alloying Cu with Pd	15
$Ru_{0.5}Cu_{0.5}$	Solution-phase co-reduction	Nanoparticles (RuCu alloy and bulk Cu)	CO oxid/ Langmuir−Hinshelwood	16
CuAg	Electro-deposition	Wire-like (Cu)	CO_2RR/ Cu_2O overlayer and Ag	17
$CoCu/SiO_2$	Wetness co-impregnation	CoCu nanoalloy	FTS / CoCu covered by Cu	18
CuCo	Deposition	2D islands (Co substituting Cu clusters)	CO adsorption/ Bimetallic CuCo	19
CuIn	Wet chemical	Nanowires (In, In^{3+}, Cu, Cu^{2+})	CO_2RR/ Cu−In interface	20
Cu-In	Deposition	Large irregularly shaped grains (In, Cu)	CO_2RR/In located on the edge sites	21
Cu atom-pair	Wet chemical	Nanowires (Cu_1^0-Cu_1^{x+} pair)	CO_2RR/ Biatomic activating	22
CuSn	Co-deposition	Nanoparticles (CuSn alloy)	CO_2RR/ Alloying Cu and Sn	23
$Cu_{2-x}Se(y)$	Solvothermal synthesis	Nanoparticles (Cu, Cu(I), Cu(II), Se)	CO_2RR/ Cu active sites	24

Zn/Cu	Deposition	Layer (ZnO_x, ZnCu alloy)	CO_2RR/ Zn/Cu(997) step sites	25
Ni-Cu/CeO_2	Wet chemical	Nanoparticles (Cu^{2+}, Cu^{+}/Cu^{0}, Ni^{0}, Ni^{2+})	HT-WGS/ One-site carboxyl	26

CH_3OH oxid oxidation of methanol; CO oxid oxidation of carbon monoxide; CO-PROX preferential oxidation of carbon monoxide; CO_2RR reduction reaction of carbon dioxide; ORR oxygen reduction reaction; Oxid oxidation.

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