Electronic Supplementary Material (ESI) for Catalysis Science & Technology.

Supplementary Information

An Efficient Catalyst of CuPt/TiO_2 for Photocatalytic Direct Dehydrogenation of Methanol to Methyl Formate at Ambient Temperature

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Table S1. Catalytic performance of various catalysts in the oxidative dehydrogenation of methanol under thermal condition

Entry	Support	Loading	Temp. (℃)	Conv. MeOH (%)	Sel. MF (%)	by-products
1[1]	SiO_2	PdCu	160	65	92	CO_2
2[2]	VTiO	rGO	135	99.6	99.2	CO_2
3[3]	CeO_2	ReOx	240	40	90	CO_2,H_2CO,Methylal
4[4]	Sn-Mo-O	--	225	50	35-50	CO_2,H_2CO,H_3COCH_3
5[5]	Sn-Mo(7:3)	--	160	72	90	CO,CO_2,H_2CO,HCOOH
6[6]	Vanadia-titania -sulfate	--	145	98.7	98.6	H_2CO,Methylal,H_3COCH_3
7[7]	TiO_2	AuPd	230	25	70	CO_2
8[8]	SiO_2	Pd	80	88	72	CO_2
9[9]	CNT	RuO_2	120	20	33	CO_2,H_2CO,Methylal
10[10]	TiO_2	Pd	80	78	52	CO_2
11[11]	Fe_2O_3	Pd	80	76	81	CO,CO_2
12[12]	Al-fiber	Au	140	50	90	CO_2,H_2CO
13[13]	Graphene	AuPd	70	90	100	--
14[14]	TiO_2	PdPt	50	78	67	CO_2
15[15]	Al-fiber	Porous Au	160	35	85	CO_2,H_2CO
16[16]	Porous Au	--	80	60	97	CO_2
17[17]	TiO_2	V_2O_5	100-150	85	82.5	CO,CO_2,H_2CO,HCOOH, Methylal
18[18]	SiO_2	AuPd	130	57	72.7	CO_2
19[19]	ZrO_2	RuOx	100	20	90.3	CO_2,H_2CO
20[20]	ZrO_2	RuOx	100	15	96	CO_2,H_2CO
21[21]	ZrO_2	RuOx	100	20	96	CO_2,H_2CO
22[22]	TS-1	VOx	170	56.7	16.2	COx,H_2CO,Methylal, H_3COCH_3
23[23]	TiO_2	V_2O_5	170	95	66	H_2CO,Methylal,H_3COCH_3
24[24]	TiO_2	VOx	120	44	16.87	COx,H_2CO,Methylal, H_3COCH_3
25[25]	TiO_2	V_2O_5	120	33	14.47	COx,H_2CO,Methylal, H_3COCH_3
26[26]	ZrO_2-Al_2O_3	V_2O_5	215	66	30	H_2CO,Methylal,COx
27[27]	TiO_2-SO_4^{2-}	V_2O_5	170	92	79	COx,H_2CO,Methylal, H_3COCH_3
28[28]	TiO_2	VOx	160	47	57	H_2CO,Methylal, H_3COCH_3
29[29]	TiO_2	Hollow V_2O_5	120-170	95	92	Methylal
30[30]	SBA-15	AgPt	200	30	73	CO_2,H_2CO,Methylal, H_3COCH_3

Table S2. Catalytic performance of various catalysts in the direct dehydrogenation of methanol under thermal condition

Entry	Support	Loading	Temp. (℃)	Conv. MeOH (%)	Sel. MF (%)
31[31]	hectorite	Cu	220	12	19
32[32]	TSM	Cu	400	82.1	31.8
33[33]	SiO_2	Cu	220	31.1	81.4
	Mo_2C	--	200	20	41
34[34]	W_2C	--	220	20	17
	WC	--	200	20	81
	TSM	Cu(Ⅱ)	240	44.8	100
35[35]	TSM	Cu(Ⅰ)	240	4.3	100
	SiO_2	Cu(0)	300	7.1	45
36[36]	SiO_2	Cu	180	24	90
	SiO_2	Cu	250	62	25
37[37]	TiO_2	Cu	250	21	91
	ZrO_2	Cu	250	30	63
38[38]	Cr_2O_3:SiO_2	Cu	200-270	41	35
39[39]	MO_X (M=Si,Zr,Mg,Zn,Cr and graphite)	Cu	220	41	58
40[40]	ZnO	Pd	200	20.5	80
41[41]	$LaM_{1-x}Cu_xO_3$	--	200-260	40	65
42[42]	ZnO	Cu	200	20	35
43[43]	SiO_2	Cu-PAN	250	45.4	97.4
	Clay (Lapo)	Cu	200	35.8	82.2
44[44]	Clay (Sapo)	Cu	200	9.9	12.1
	TSM	Cu	200	19.7	89.3
45[45]	$CuAl_2O_4$	--	310	63.6	57.0
46[46]	Cr_2O_3	Cu	207	48	99
47[47]	SiO_2	Cu	230	50	75-80
48[48]	copper chromite copper hydroxysilicate copper-zinc hydroxysilicate	--	150-270	10	100
49[49]	Zeolite	Cu	280	27.9	72.4
50[50]	$mSiO_2$	Cu	230	40	80
51[51]	CuMgO	Pd	250	16.7	88.1

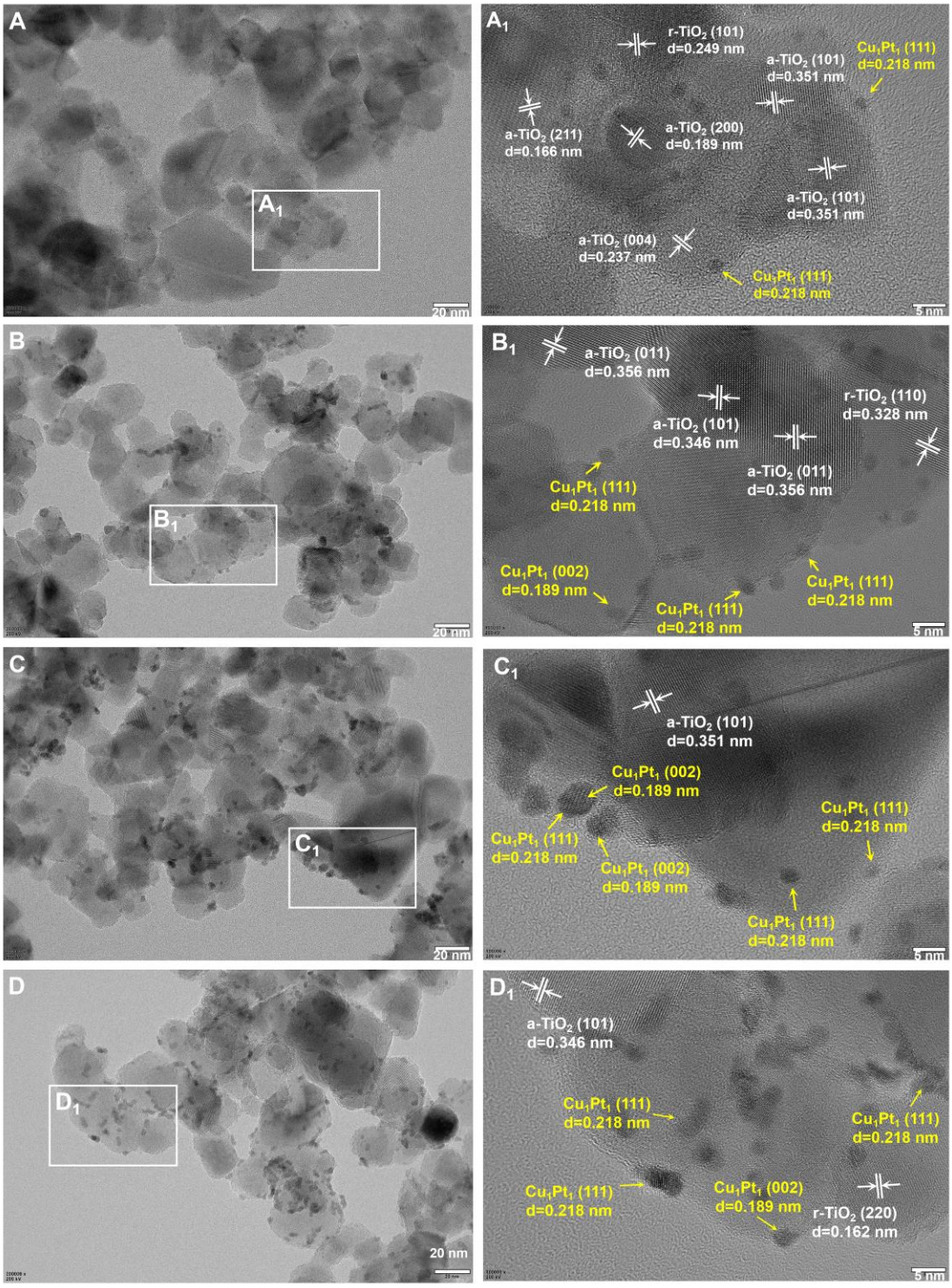

Figure S1.TEM and HR-TEM images of catalysts with different metal content. A.1% CuPt (1:1)/TiO_2; B.2% CuPt (1:1)/TiO_2; C.4% CuPt (1:1)/TiO_2 and D.6% CuPt (1:1)/TiO_2.

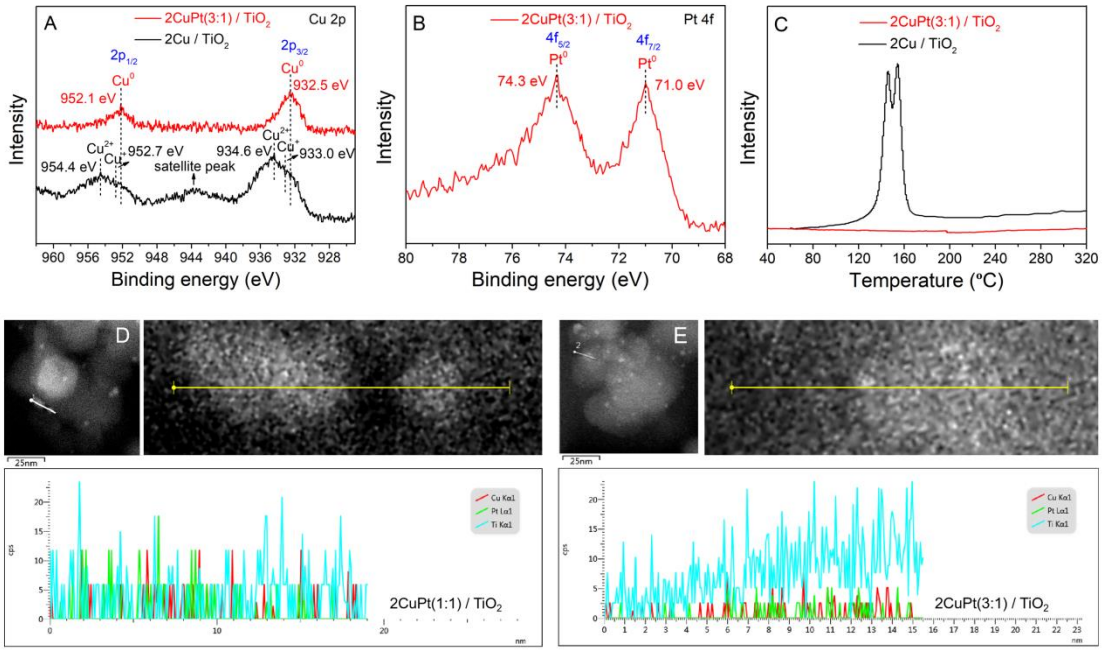

Figure S2. XPS (A, B), TPR (C) and line scan based on the HADDF-stem (D, E) of catalysts with different metal content.

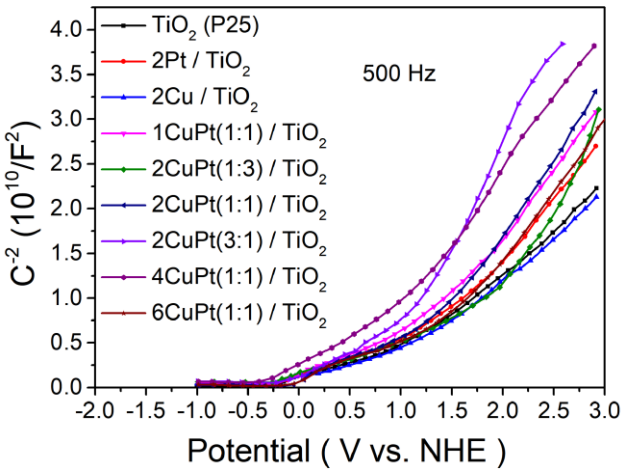

Figure S3. Mott-Schottky diagram of the catalyst at 500 Hz in 0.2 M Na_2SO_4 solution.

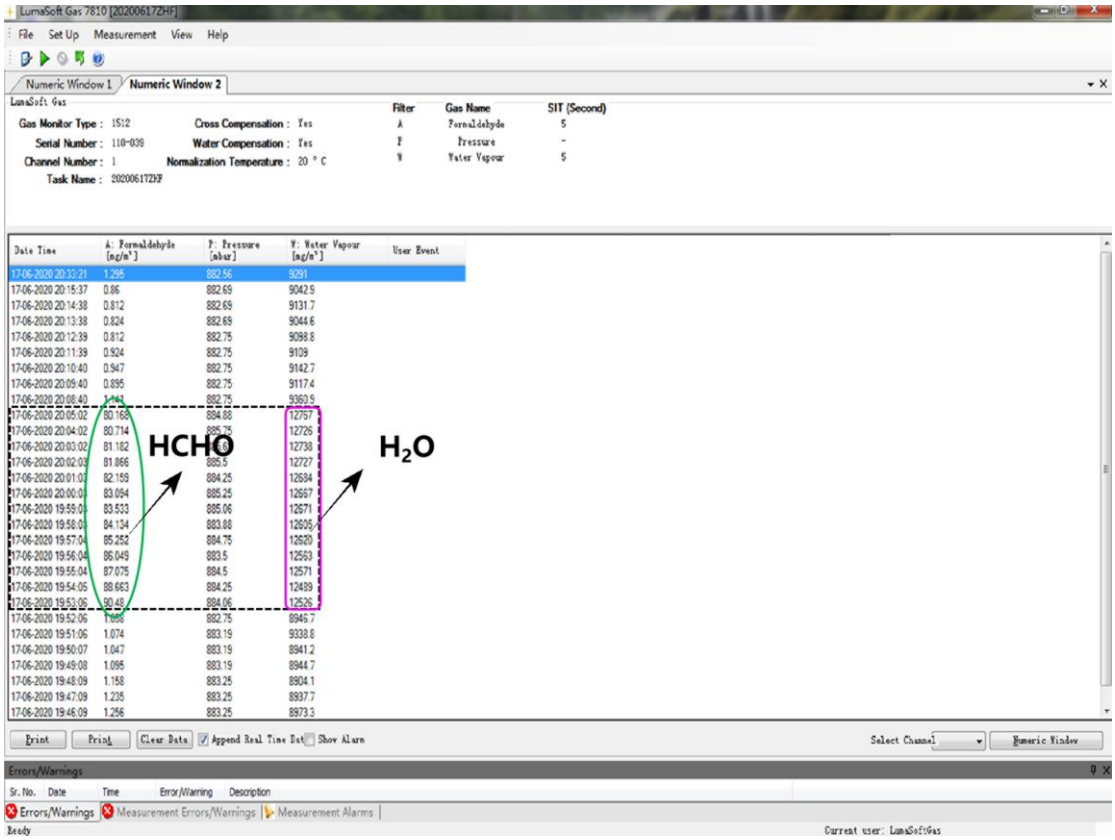

Figure S4. The HCHO and H_2O were detected in the reaction by Photoacoustic Gas Monitor- Innova 1512 installed by LumaSense Technologies.

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