

Influence of preparation methods on the catalytic activity of Pd-Cu/Mn₂O₃ catalyst in the hydrogenation of 1, 3-butadiene

Tareque Odoom-Wubah,^a Qun Li,^b Min Chen,^b Huihuang Fang,^a Bernard Baffour Asare Bediako,^c Isroil Adilov^b, Jiale Huang,^{b} Qingbiao Li^{a, b, *}*

^aDepartment of Chemistry, College of Chemistry and Chemical Engineering, Xiamen University, Xiamen 361005, PR China, ^bDepartment of Chemical and Biochemical Engineering, College of Chemistry and Chemical Engineering, Xiamen University, Xiamen 361005, PR China,

^cCollege of Chemistry& Life Science, Quanzhou Normal University, Quanzhou 362000, PR China.^d

*Corresponding author. Tel.: (+86) 592-2183088; fax: (+86)592-2184822. *E-mail address*: cola@xmu.edu.cn.

*Corresponding author. Tel.: (+86) 592-2189595; fax: (+86)592-2184822. *E-mail address*: keqb@xmu.edu.cn.

Table of contents:

Figure S1. (A) High- resolution TEM (HRTEM) image and (B) selected-area electro-diffraction (SAED) pattern of the as-produced biogenic Pd-Cu_{0.06} NPs

Figure S2. XPS analysis of the IPC, DPU and DCPVP showing the O 1s and C 1s regions

Figure S3. DRIIFTS and CO adsorption analysis of the various Pd-Cu/Mn₂O₃ catalysts, under CO/N₂ for 10 min Pd-Cu) and then N₂ for 10 min (A) SI (B) AR (C) IPC (D) DPU and (E) DCPVP

Figure S4. DRIIFTS and CO adsorption analysis of the various Pd-Cu_x/Mn₂O₃ catalysts, where x= 0.02 to 0.1 g under CO/N₂ for 15 min and then N₂ for 10 min

Figure S5. The catalytic performance of the single Cu and Pd/Mn₂O₃ catalyst prepared using the diverse methods

Table S1. Binding Energies of the different Pd-Cu NPs synthesized by different methods

Table S2. Catalytic performance of the supported Pd-Cu and their mono metallic catalysts in 1, 3- butadiene hydrogenation prepared using the SI method

Table S3. Catalytic performance of the supported mono metallic Pd and Cu catalysts in 1, 3- butadiene hydrogenation prepared using the different methods

Table S4. Catalytic performance of the Pd-Cu_{0.06}/Mn₂O₃ catalysts in 1, 3-butadiene hydrogenation using the different methods

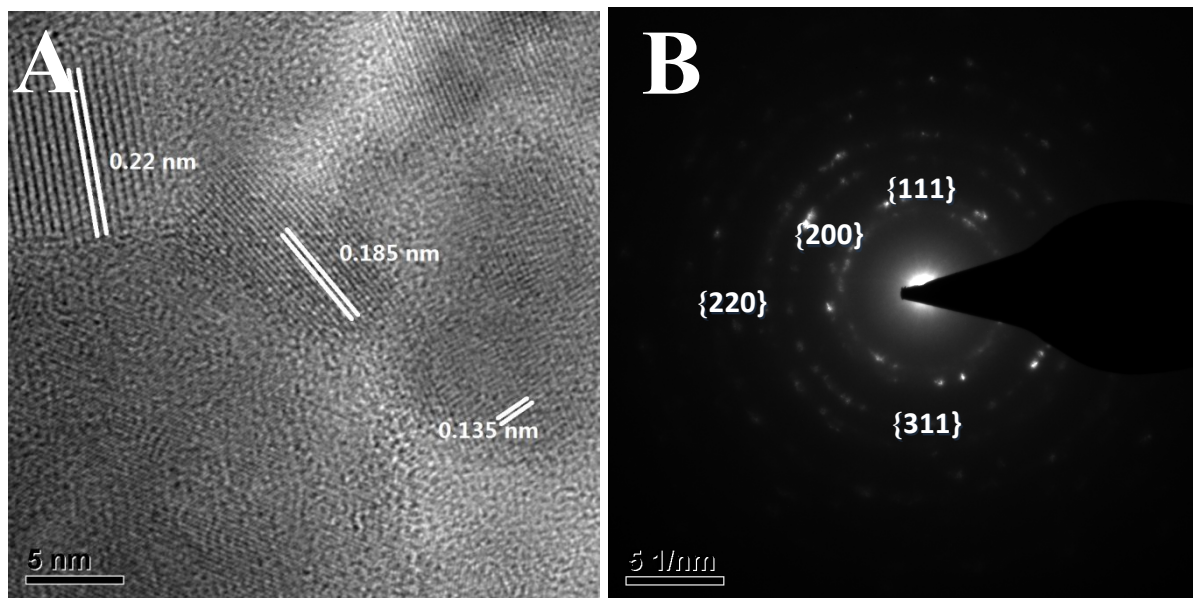


Figure S1. (A) High- resolution TEM (HRTEM) image and (B) selected-area electro-diffraction (SAED) pattern of the as-produced biogenic Pd-Cu_{0.06} NPs

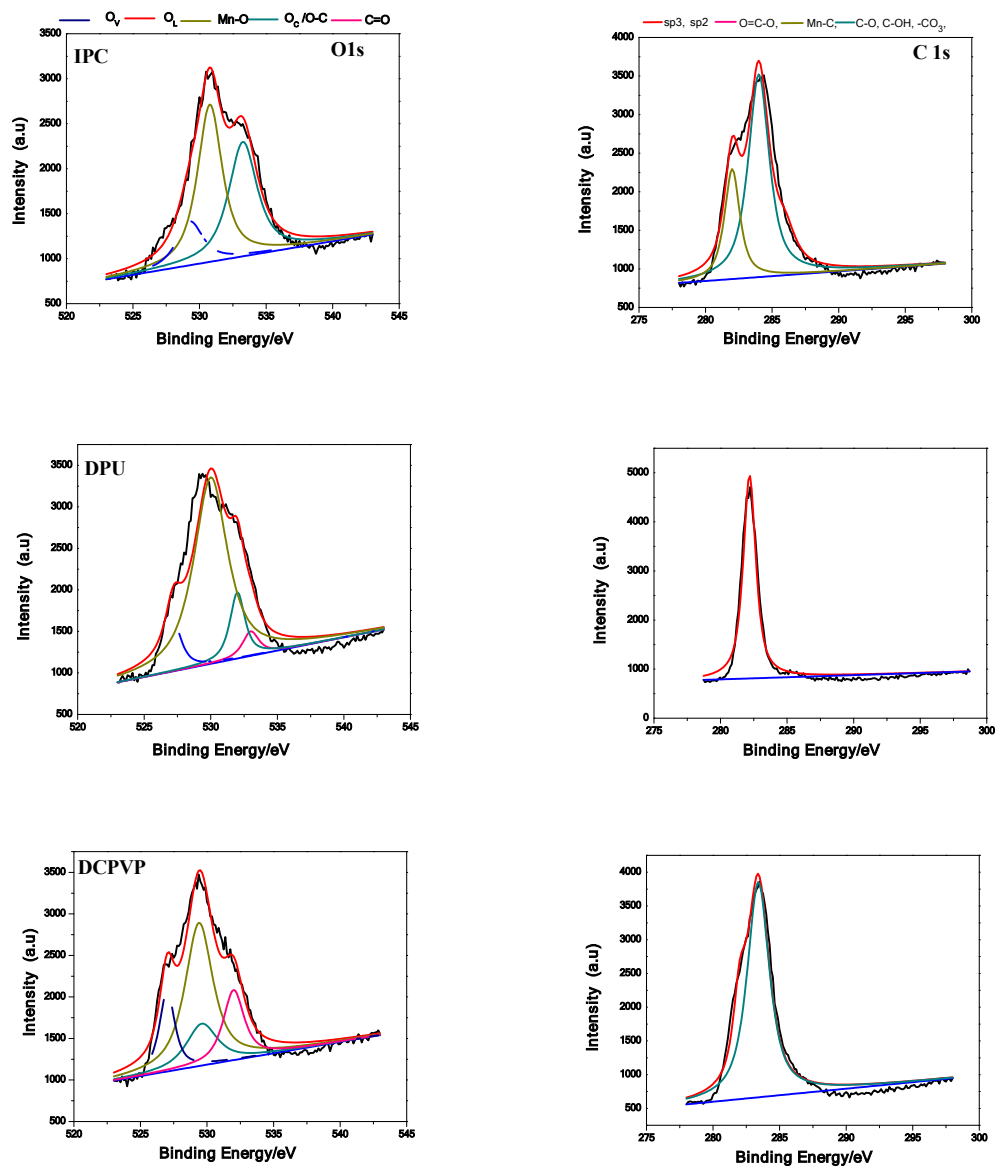


Figure S2. XPS analysis of the IPC, DPU and DCPVP showing the O 1s and C 1s regions

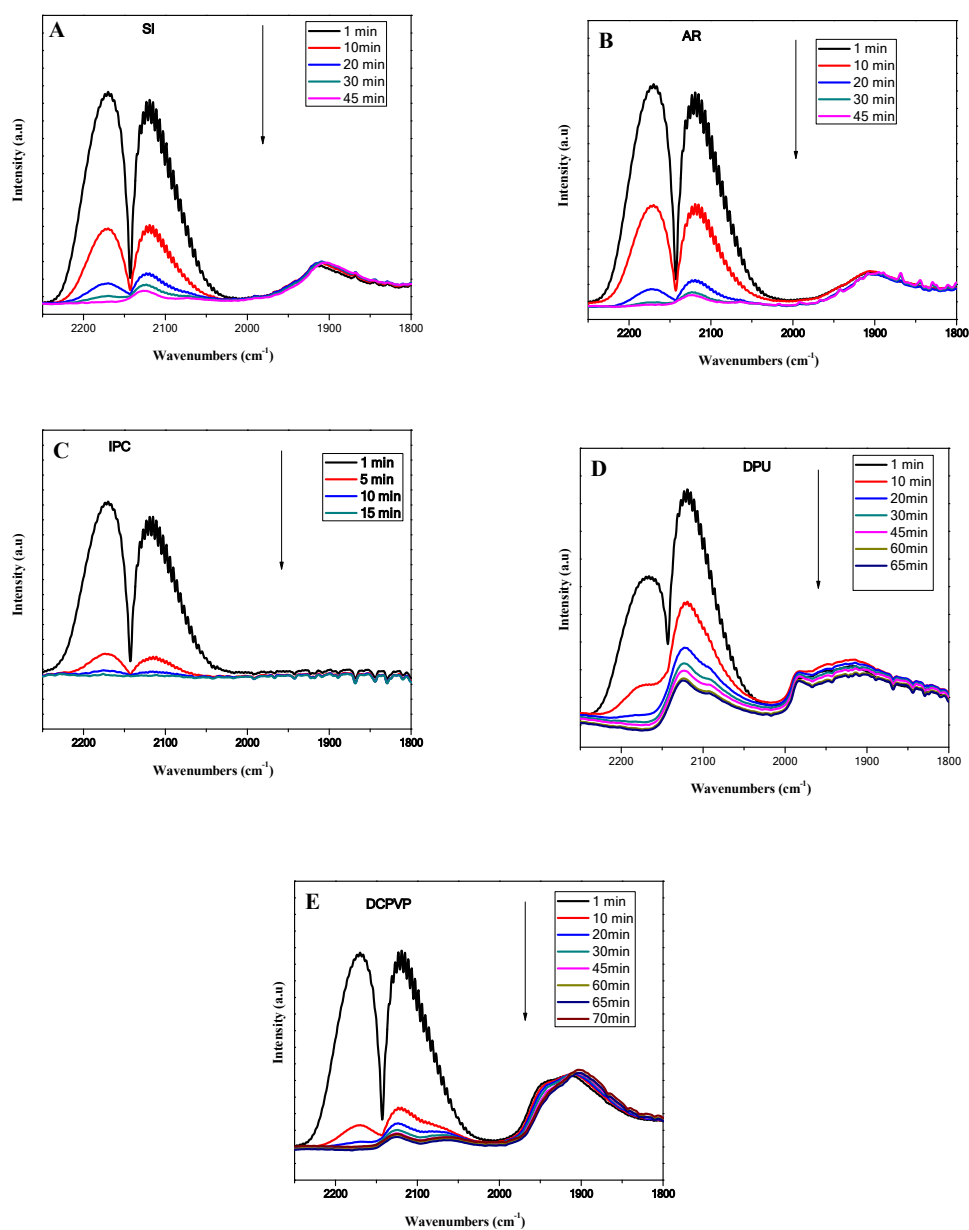


Figure S3. DRIIFTS and CO adsorption analysis of the various Pd-Cu/Mn₂O₃ catalysts, under CO/N₂ for 10 min Pd-Cu) and then N₂ for 10 min (A) SI (B) AR (C) IPC (D) DPU and (E) DCPVP

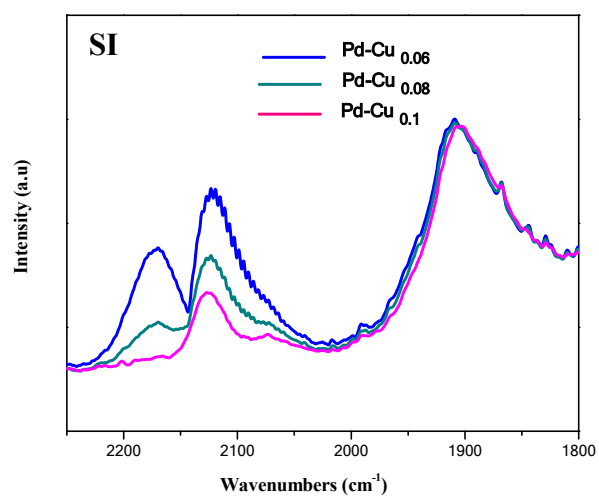


Figure S4. DRIIFTS and CO adsorption analysis of the various Pd-Cu_x/Mn₂O₃ catalysts, where x= 0.02 to 0.1 g under CO/N₂ for 15 min and then N₂ for 10 min

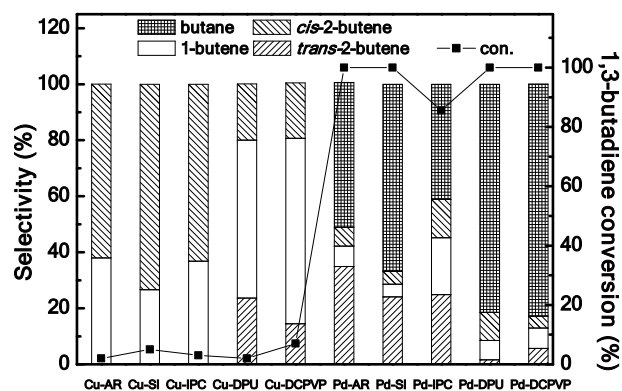


Figure S5. The catalytic performance of the single Cu and Pd/Mn₂O₃ catalyst prepared using the diverse methods

Table S1. Binding Energies of the different Pd-Cu NPs synthesized by different methods

Pd-Cu	Binding Energy /eV			
	Cu	Cu	Pd	Pd
	2p _{3/2}	2p _{1/2}	3d _{5/2}	3d _{1/2}
SI	932.0	952.0	335.7	341.1
AR	931.1	951.0	335.8	341.0
IPC	932.0	943.0	338.4	343.9
DPU	932.5	951.2	335.2	341.0
DCPVP	931.7	952.0	335.8	341.2

Table S2. Catalytic performance of the supported Pd-Cu and their mono metallic catalysts in 1, 3- butadiene hydrogenation prepared using the SI method

Sample	Selectivity (%)				Conversion (%)	Yield (%)
	Butane	<i>Trans</i> -2-butene	1-butene	<i>Cis</i> -2-butene		
Pd-Cu _{0.02} / Mn ₂ O ₃	66.2	7.0	16.7	10.1	100	33.8
Pd-Cu _{0.04} / Mn ₂ O ₃	25.2	25.6	29.5	19.8	100	74.8
Pd-Cu _{0.06} / Mn ₂ O ₃	8.1	21.2	58.5	12.2	99.1	91.0
Pd-Cu _{0.08} / Mn ₂ O ₃	3.6	22.7	67.7	6.5	30.0	33.20
Pd-Cu _{0.1} / Mn ₂ O ₃	2.7	19.3	61.0	16.1	3.0	3.0
Cu _{0.06} / Mn ₂ O ₃	0	0	12	88	12.0	12
Pd / Mn ₂ O ₃	65.3	2.5	18.6	13.6	100	34.7

Table S3. Catalytic performance of the supported mono metallic Pd and Cu catalysts in 1, 3- butadiene hydrogenation prepared using the different methods

Sample	Selectivity (%)				
	Butane	<i>Trans</i> -2-butene	1-butene	<i>Cis</i> -2-butene	Conversion
Cu/Mn ₂ O ₃ -AR	0	40.0	38.0	22.0	2.0
Cu/Mn ₂ O ₃ -SI	0	0.0	26.6	73.4	5.1
Cu/Mn ₂ O ₃ -IPC	0	0.0	36.8	63.2	3.6
Cu/Mn ₂ O ₃ -DPU	0	23.6	56.3	20.1	2.0
Cu/Mn ₂ O ₃ - DCPVP	0	14.5	66.2	19.8	7.0
Pd/Mn ₂ O ₃ -AR	51.7	34.9	7.3	6.70	100
Pd/Mn ₂ O ₃ -SI	66.8	24.1	4.5	4.60	100
Pd/Mn ₂ O ₃ -IPC	41.2	24.9	20.4	13.7	85.6
Pd/Mn ₂ O ₃ -DPU	81.5	1.6	6.9	10.0	100
Pd/Mn ₂ O ₃ -DCPVP	82.9	5.7	7.3	4.23	100

Table S4. Catalytic performance of the Pd-Cu_{0.06}/Mn₂O₃ catalysts in 1, 3-butadiene hydrogenation using the different methods

Sample	Selectivity (%)				
	Butane	<i>Trans</i> -2-butene	1-butene	<i>Cis</i> -2-butene	Conversion
Pd-Cu/Mn ₂ O ₃ -AR	6.0	29.8	60.7	6.5	88.6
Pd-Cu/Mn ₂ O ₃ -SI	8.1	21.2	58.5	12.2	99.1
Pd-Cu/Mn ₂ O ₃ -IPC	3.0	24.68	60.49	8.75	29.6
Pd-Cu/Mn ₂ O ₃ -DCPVP	73.6	2.6	17.6	6.17	100
Pd-Cu/Mn ₂ O ₃ - DPU	55.7	12.72	21.56	10.1	100