The importance of direct reduction in the synthesis of highly active Pt-Sn/SBA-15 for *n*-butane dehydrogenation

Lidan Deng,[a,b,e] Hiroki Miura,[b,c,d] Tomoyo Ohkubo,[b] Tetsuya Shishido,[b,c,d]* Wang Zheng,[a] Saburo Hosokawa,[a,c] Kentaro Teramura,[a,c] Tsunehiro Tanaka[a,c]*

[a]Department of Molecular Engineering, Graduate School of Engineering, Kyoto University, Katsura, Nishikyo-ku, Kyoto 615-8510, Japan

[b]Department of Applied Chemistry for Environment, Graduate School of Urban Environmental Sciences, Tokyo Metropolitan University,1-1 Minami-Osawa, Hachioji, Tokyo 192-0397, Japan

[c]Elements Strategy Initiative for Catalysts & Batteries Kyoto University, 1-30 Goryo-Ohara, Nishikyo-ku, Kyoto 615-8245, Japan

[d]Research Centre for Hydrogen Energy-based Society, Minami-Osawa, Hachioji, Tokyo 192-0397, Japan

[e]School of Chemistry and Environmental Engineering, Wuhan Institute of Technology, No.206, Guanggu 1st road, Wuhan 430073, China

* Corresponding author:Tel: +81-42-677-2850 Fax: +81-42-677-2821 (T. Shishido)

E-mail addresses: shishido-tetsuya@tmu.ac.jp (T. Shishido)

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Figure S6 Selected DRIFT spectra of CO adsorbed on A) Pt-Sn/SiO_2_773 K O_2, B) Pt-Sn/SiO_2_1073 K O_2, C) Pt-Sn/SiO_2_CR (1073 K O_2), D) Pt-Sn/SBA-15_773 K O_2, E) Pt-Sn/SBA-15_1073 K O_2, and F) Pt-Sn/SBA-15_CR (1073 K O_2).

Table S1 Physical properties of supported Pt-Sn catalysts.

Catalyst[a]	Molar ratio of Pt:Sn	Pt loading amount (wt%)	BET surface area[b] ($m^2 \cdot g^{-1}$)	Pore volume[c] ($cm^3 \cdot g^{-1}$)
3Pt1Sn/SBA-15	3:1	3	549.4	0.65
2Pt1Sn/SBA-15	2:1	3	553.1	0.65
1Pt1Sn/SBA-15	1:1	3	535.5	0.64
1Pt1Sn/SiO_2	1:1	3	331.5	0.87

a: The catalysts were prepared with DR method.

b: The surface area of SBA-15 and SiO_2 is 849.1 $m^2 \cdot g^{-1}$, 325.0 $m^2 \cdot g^{-1}$ respectively.

c: The pore volume of SBA-15 is 0.95 $cm^3 \cdot g^{-1}$.

Figure S1 Catalytic performances of supported Pt/SBA-15_DR (1073 K) (A) and 2Pt1Sn/SBA-15_DR (B) catalysts during n-butane dehydrogenation.

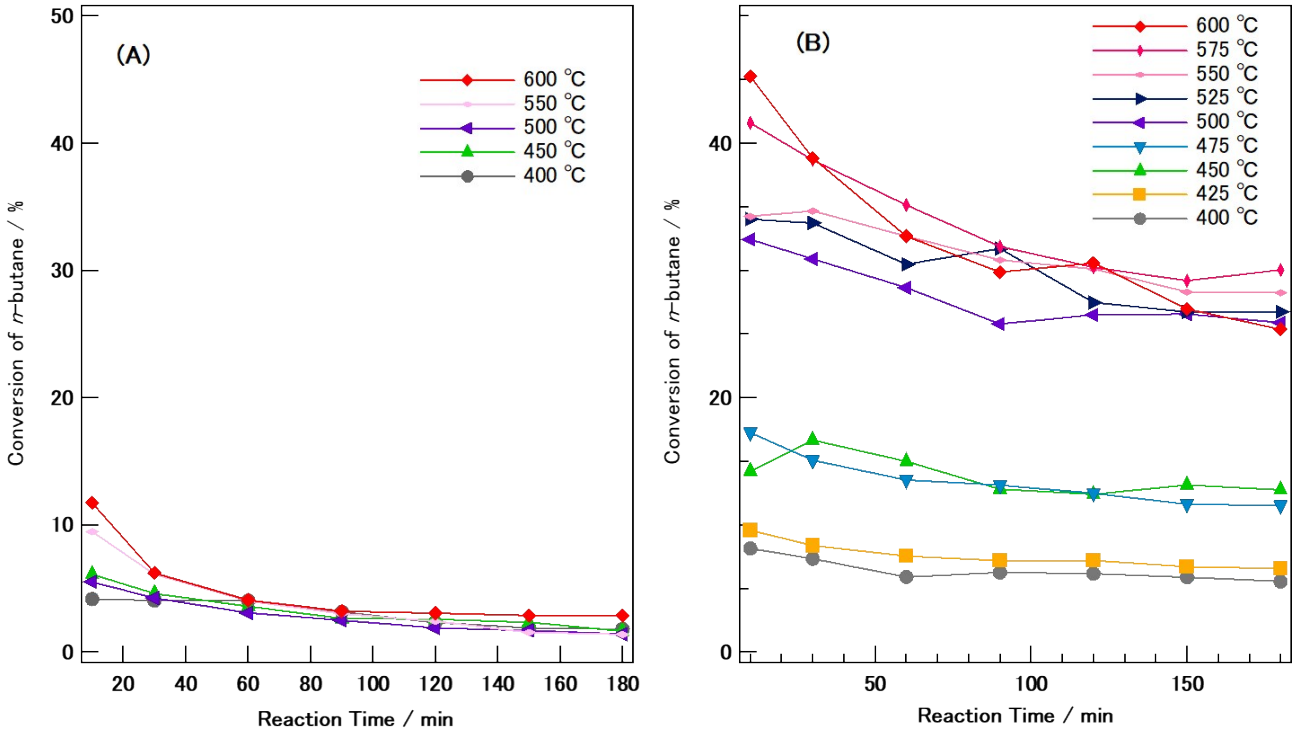


Figure S2 Temperature programmed oxidation (TPO) spectra of the 1Pt1Sn/SBA-15 catalysts after the reaction at the different temperatures. (The catalyst: 1Pt1Sn/SBA-15_DR, 50mg; the reaction temperature: 573~873 K; the reaction time: 180 min.)

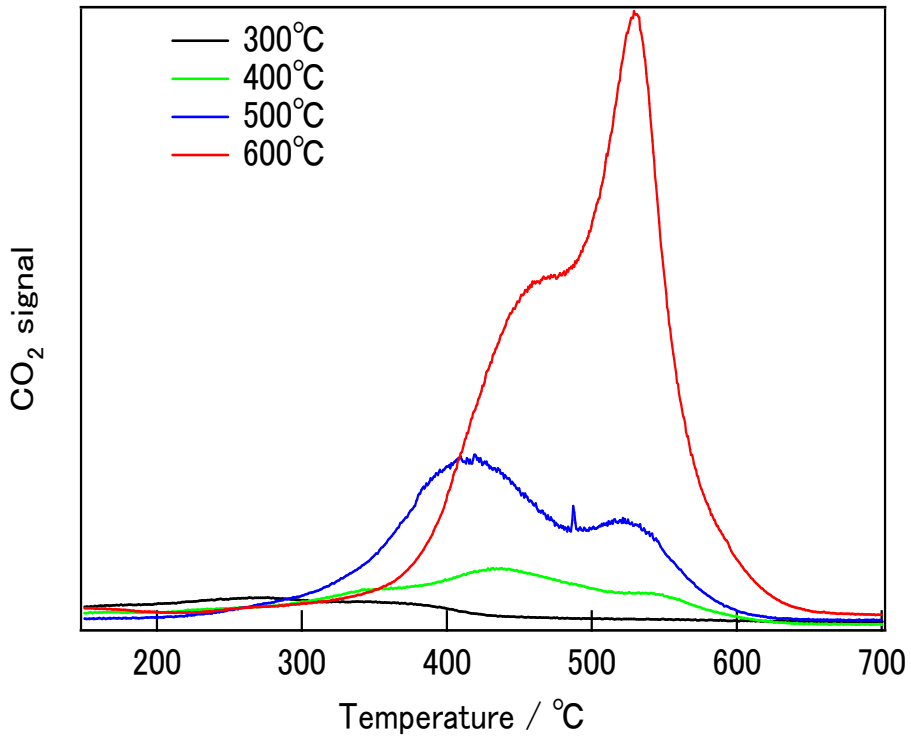
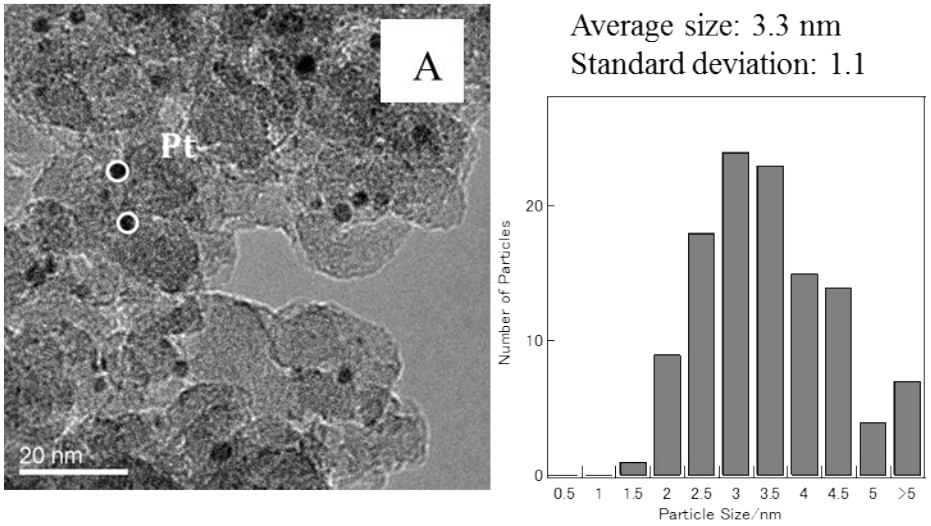
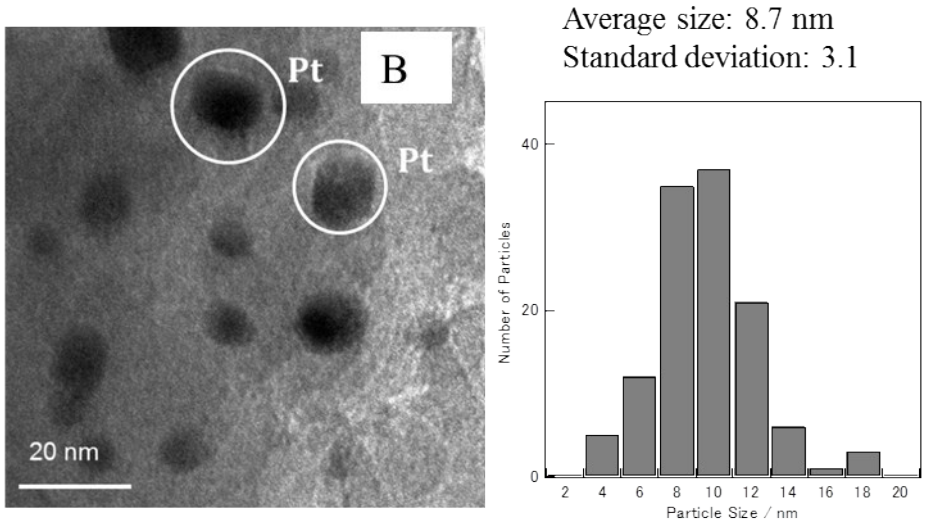
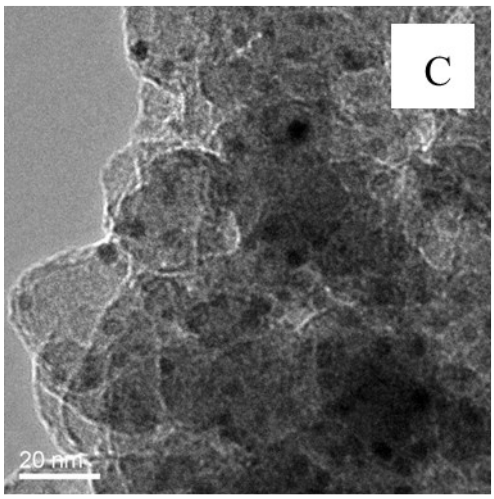


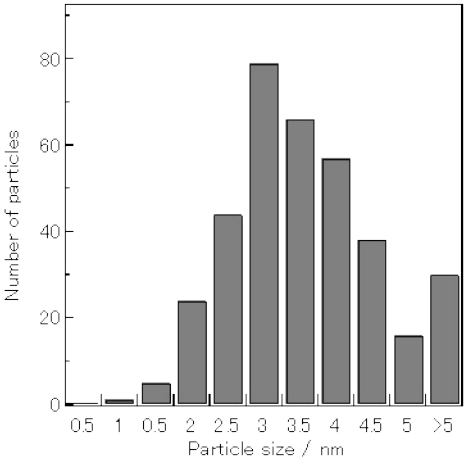
Figure S3 TEM images and the particle size histograms of (A) Pt-Sn/SiO_2_773K O_2,(B) Pt-Sn/SiO_2_1073K O_2, (C) Pt-Sn/SiO_2_CR (773K O_2), and (D) Pt-Sn/SiO_2_DR.

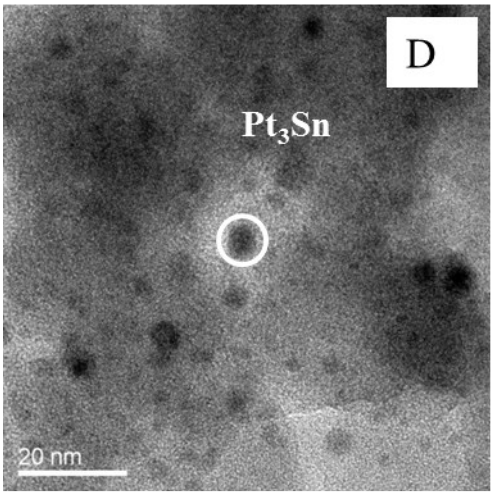






Average size: 3.4 nm
Standard deviation: 1.1





Average size: 2.6 nm
Standard deviation: 1.4

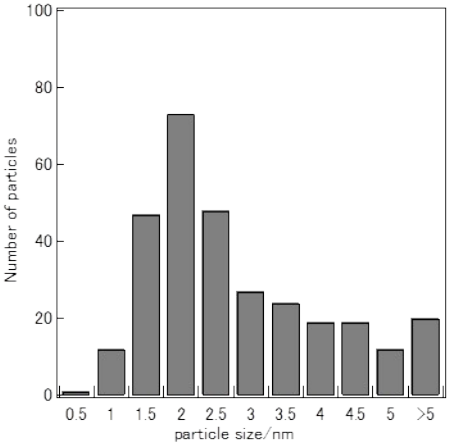
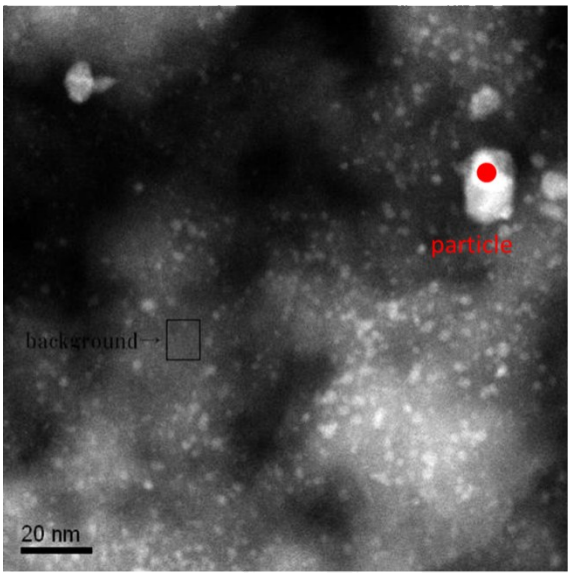


Figure S4 Spot-EDS analysis of Pt-Sn/SiO_2_DR.



Background

	mass %	atom %
O	31.5	47.0
Si	60.8	51.8
Sn	3.5	0.7
Pt	4.2	0.5

particle

	mass %	atom %
O	-	-
Si	-	-
Sn	18.4	27.0
Pt	81.7	73.0

Figure S5 HAADF-STEM-EDS analysis of Pt-Sn/SBA-15_CR (1073 K O_2).

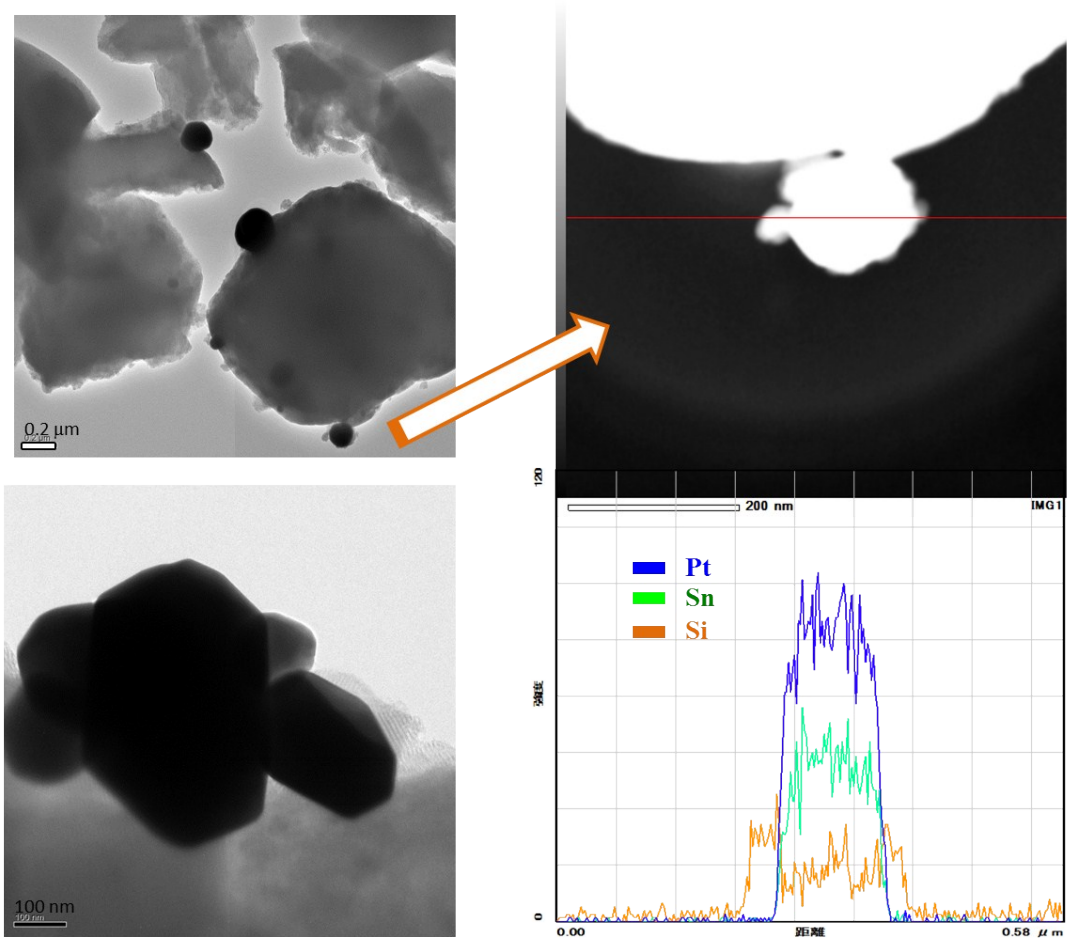
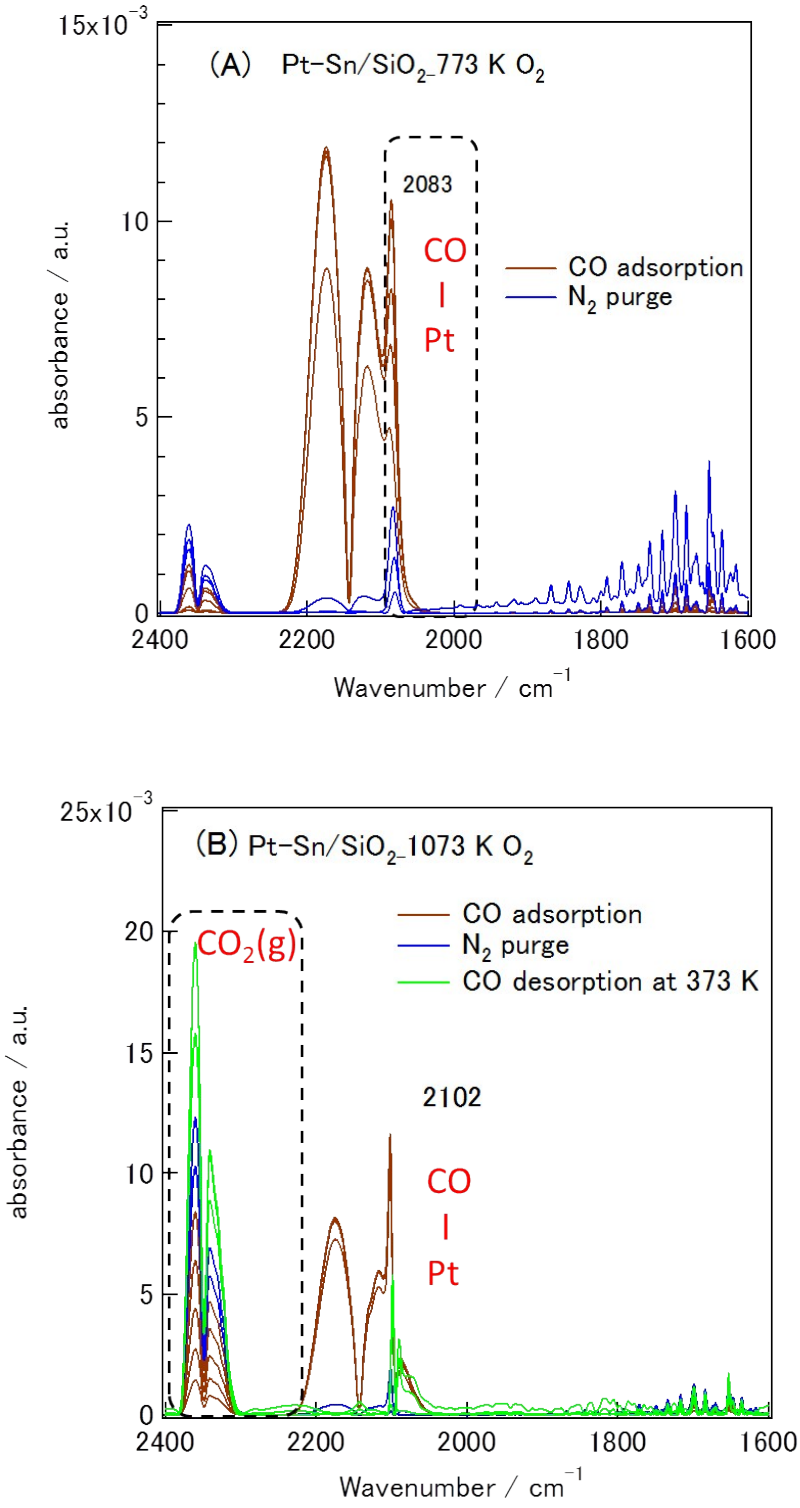
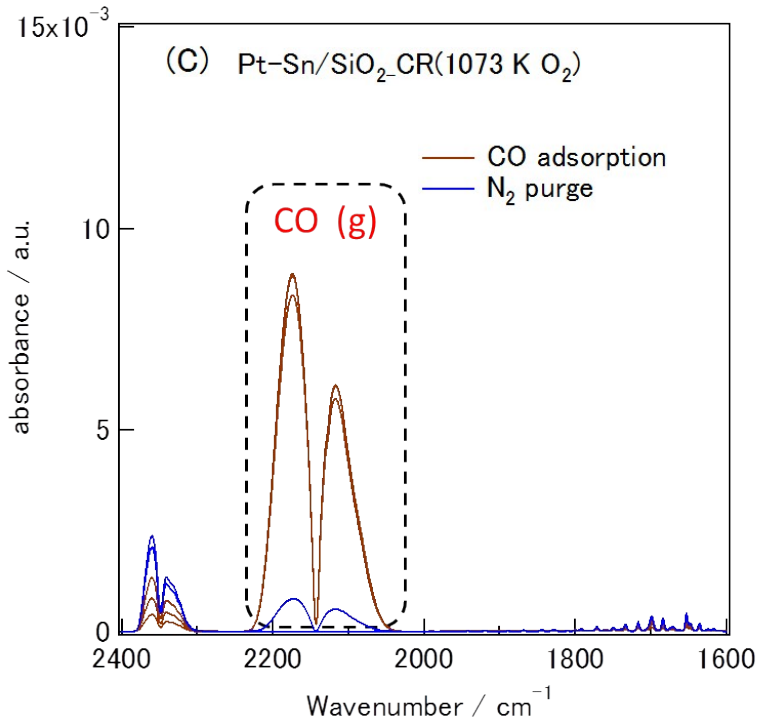
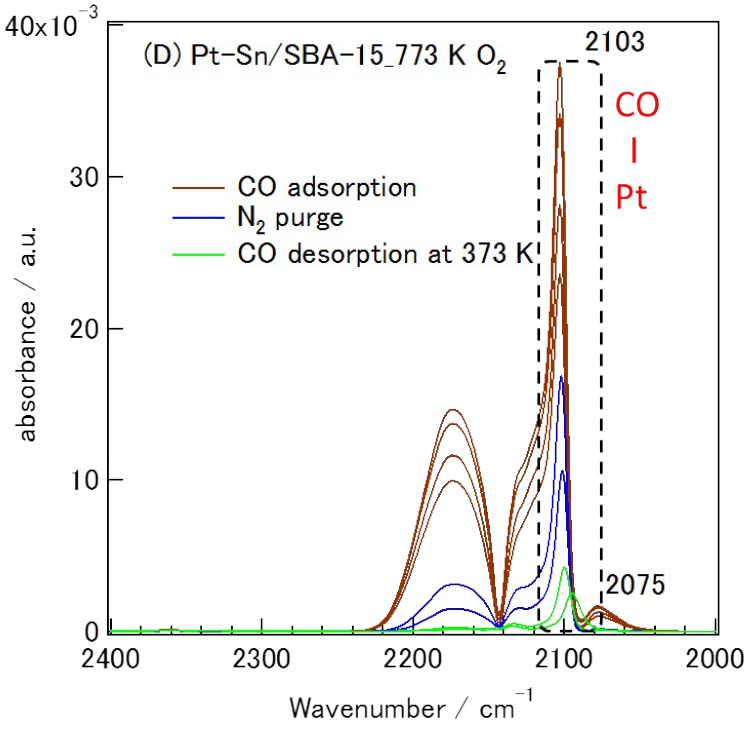
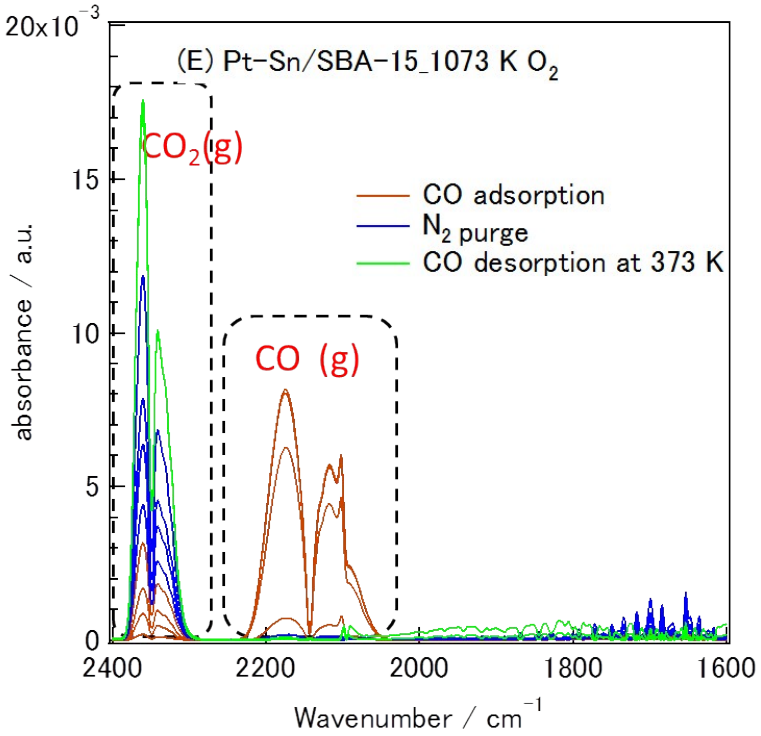


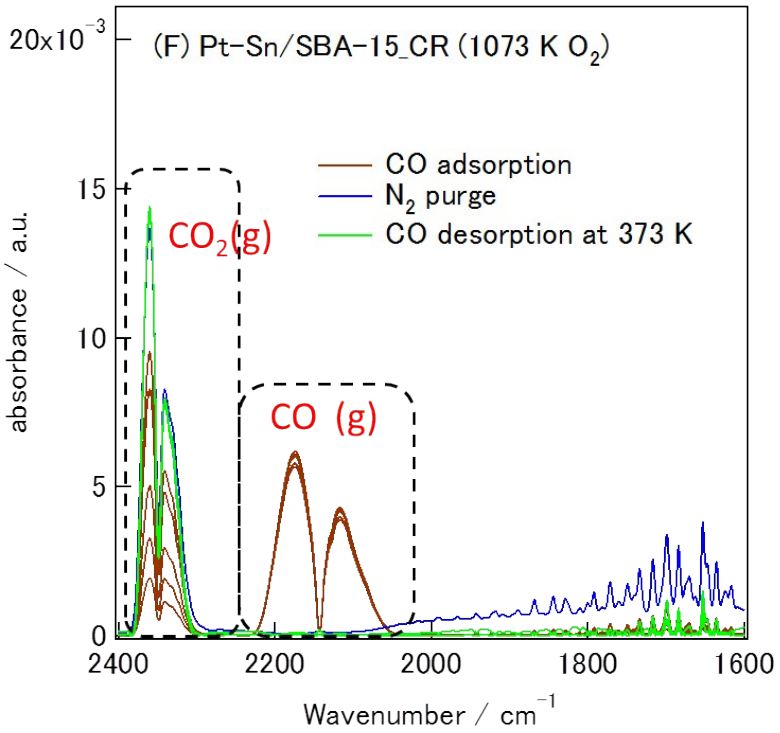
Figure S6 Selected DRIFT spectra of CO adsorbed on A) Pt-Sn/SiO_2_773 K O_2, B) Pt-Sn/SiO_2_1073 K O_2, C) Pt-Sn/SiO_2_CR (1073 K O_2), D) Pt-Sn/SBA-15_773 K O_2, E) Pt-Sn/SBA-15_1073 K O_2, and F) Pt-Sn/SBA-15_CR (1073 K O_2).




15x10^{-3}
(C) Pt-Sn/SiO$_2$_CR(1073 K O$_2$)
CO adsorption
N$_2$ purge
CO (g)
absorbance / a.u.
10
5
0
2400
2200
2000
1800
1600
Wavenumber / cm^{-1}


40x10^{-3}
(D) Pt-Sn/SBA-15_773 K O$_2$
2103
CO
I
Pt
CO adsorption
N$_2$ purge
CO desorption at 373 K
2075
absorbance / a.u.
30
20
10
0
2400
2300
2200
2100
2000
Wavenumber / cm^{-1}


20x10^{-3}
(E) Pt-Sn/SBA-15_1073 K O_2
CO_2(g)
CO adsorption
N_2 purge
CO desorption at 373 K
CO (g)
absorbance / a.u.
0
5
10
15
2400
2200
2000
1800
1600
Wavenumber / cm^{-1}


20x10^{-3}
(F) Pt-Sn/SBA-15_CR (1073 K O_2)
CO adsorption
N_2 purge
CO desorption at 373 K
CO_2(g)
CO (g)
absorbance / a.u.
0
5
10
15
2400
2200
2000
1800
1600
Wavenumber / cm^{-1}