Supporting information

Controlling the Nanoparticles Size and Shape of Pt/TiO_2 catalyst for Enhanced Hydrogenation of Furfural to Furfuryl Alcohol

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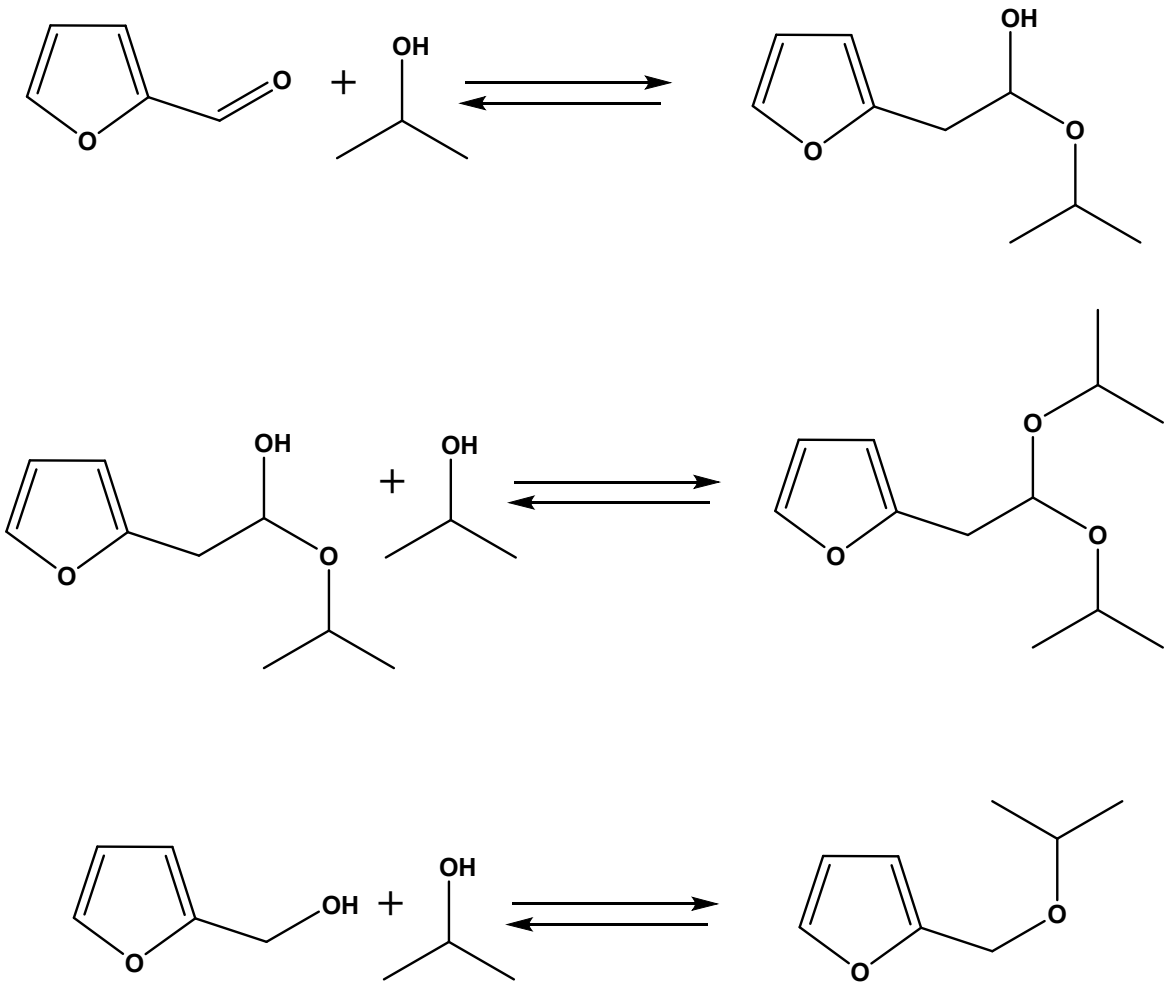


Scheme S1 Schematic representation of the formation of hemiacetal and subsequent acetalylation product from the reaction between furfural and isopropanol (solvent). Acetylation of furfuryl alcohol using isopropanol (last reaction).

Table S1: *Liquid phase hydrogenation of FF to 2-FFA over 4.2%Pt/TiO_2 catalyst – Effect of heat treatment*

Catalyst	**Heat treatment**	**Conv. (%)**	**Products Selectivity (%)**		
			2-FFA	**2-MF**	**Solvent Product**
4.2%Pt/TiO_2	Calcination	90	42	31	27
	Reduction	25	90	-	10
	Calcination + Reduction[a]	99	59	9	1

Reaction conditions: H_2 : 3 bar; Temp : 30 ^oC; FF: 4.45 mmol; Isopropanol (solvent) : 15 mL; Time : 6h; FF/Pt molar ratio : 207. [a] Rest of the products is a mixture of 4 unknown products.

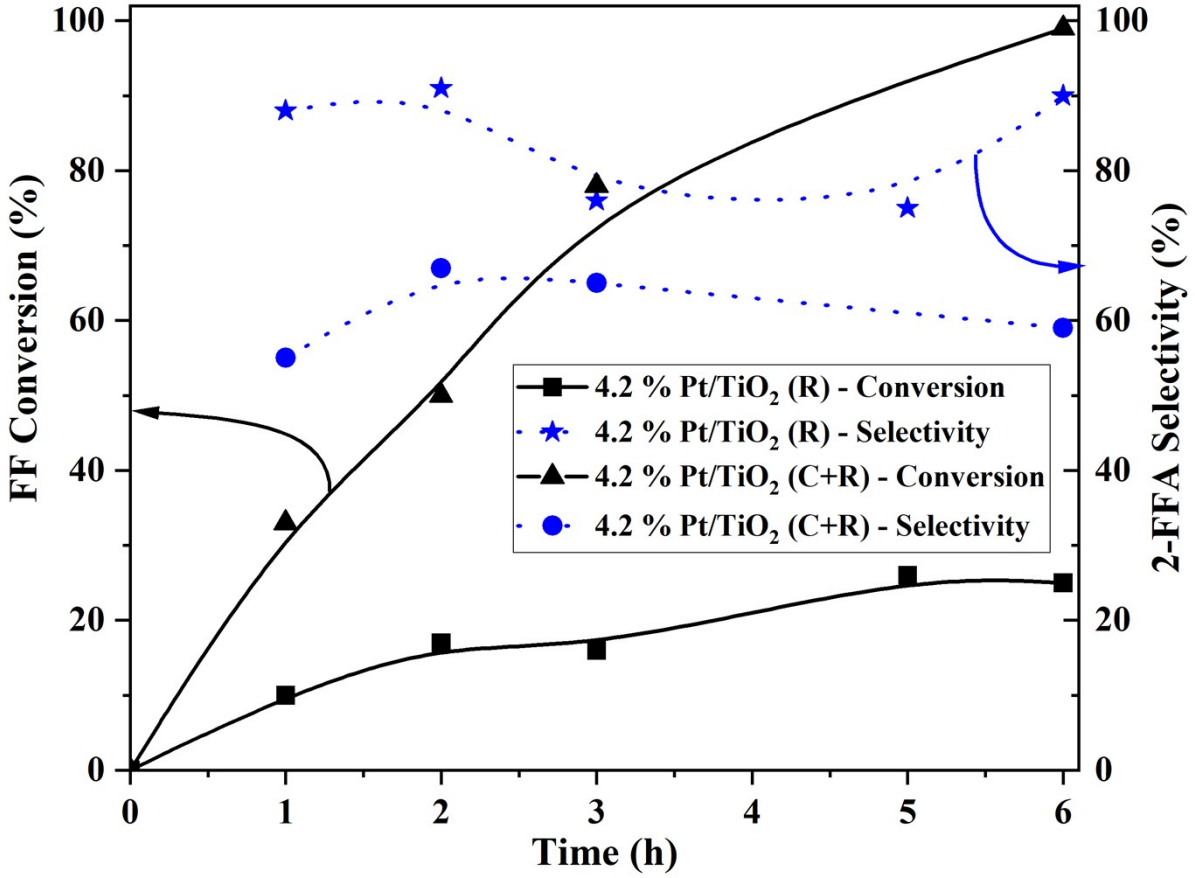


Figure S1: *Catalytic performance of 4.2%Pt/TiO_2 as a function of time for the hydrogenation of FF to 2-FFA. Effect of catalyst reduction vs calcination + reduction. Reaction conditions: H_2 : 3 bar; Temp : 30 ^oC; FF: 4.45 mmol; Isopropanol (solvent) : 15 mL; FF/Pt molar ratio : 207.*

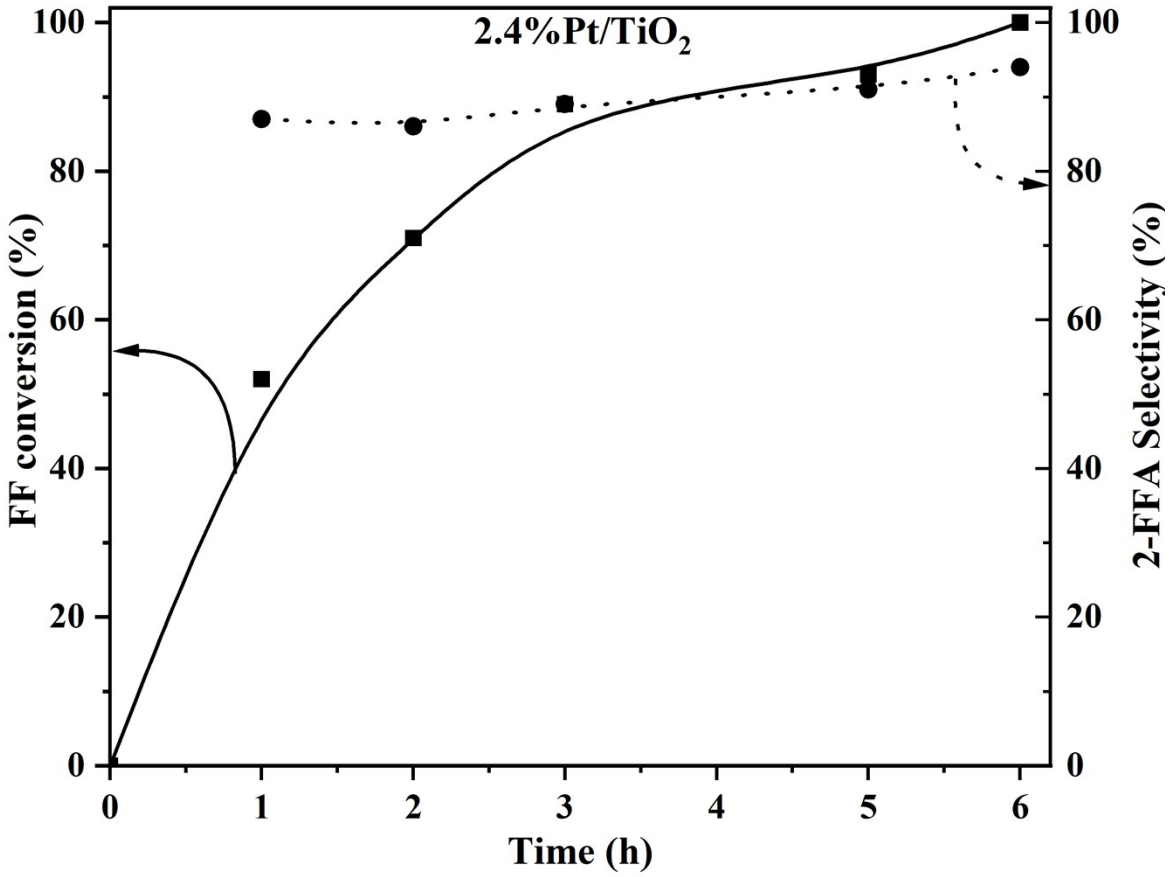


Figure S2: : *Catalytic performance of 2.4%Pt/TiO_2 (calcination + reduction) as a function of time for the hydrogenation of FF to 2-FFA. Reaction conditions: H_2 : 3 bar; Temp : 30 ^oC; FF: 4.45 mmol; Isopropanol (solvent) : 15 mL; FF/Pt molar ratio : 207.*

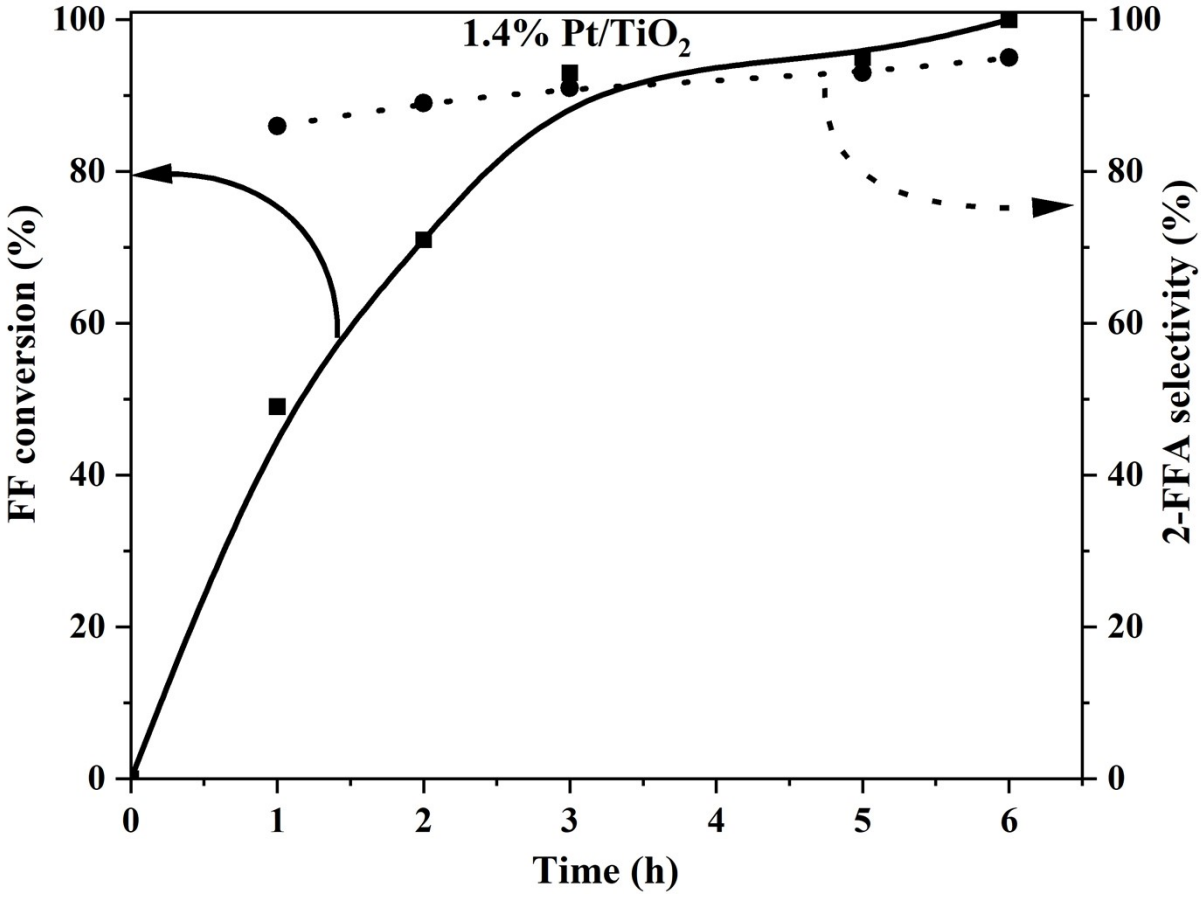


Figure S3: *Catalytic performance of 1.4%Pt/TiO_2 (calcination + reduction) as a function of time for the hydrogenation of FF to 2-FFA. Reaction conditions: H_2 : 3 bar; Temp : 30 ^oC; FF: 4.45 mmol; Isopropanol (solvent) : 15 mL; FF/Pt molar ratio : 207.*

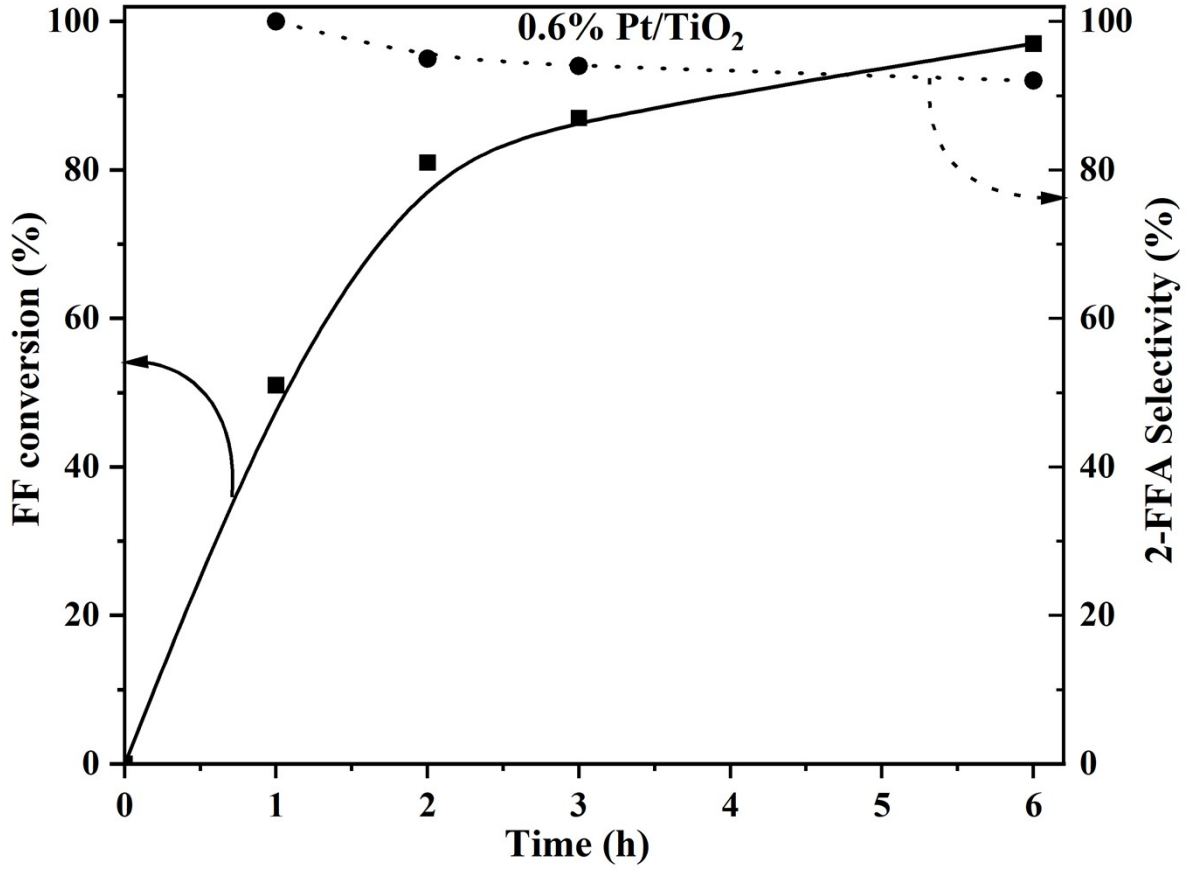


Figure S4: *Catalytic performance of 0.6%Pt/TiO_2 (calcination + reduction) as a function of time for the hydrogenation of FF to 2-FFA. Reaction conditions: H_2 : 3 bar; Temp : 30 ^oC; FF: 4.45 mmol; Isopropanol (solvent) : 15 mL; FF/Pt molar ratio : 207.*

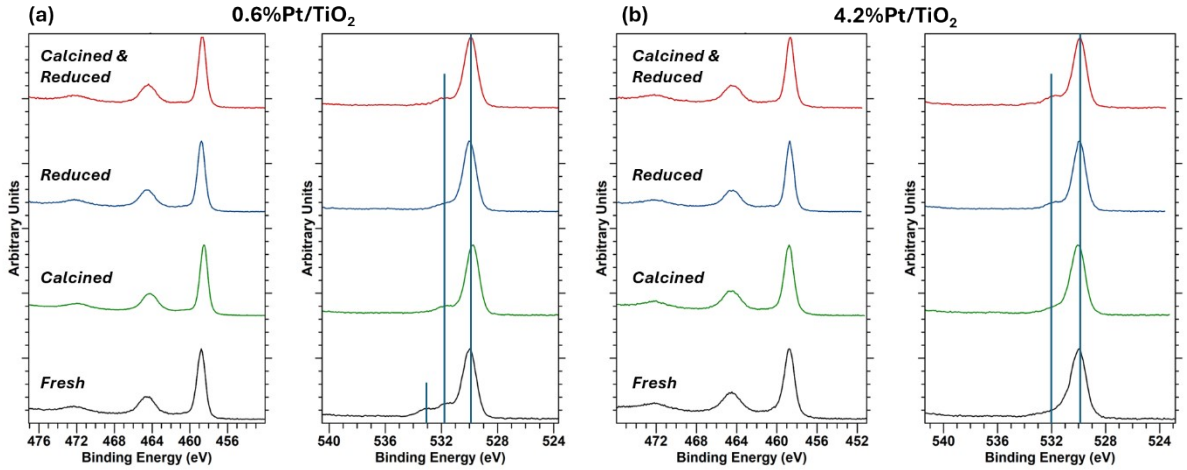
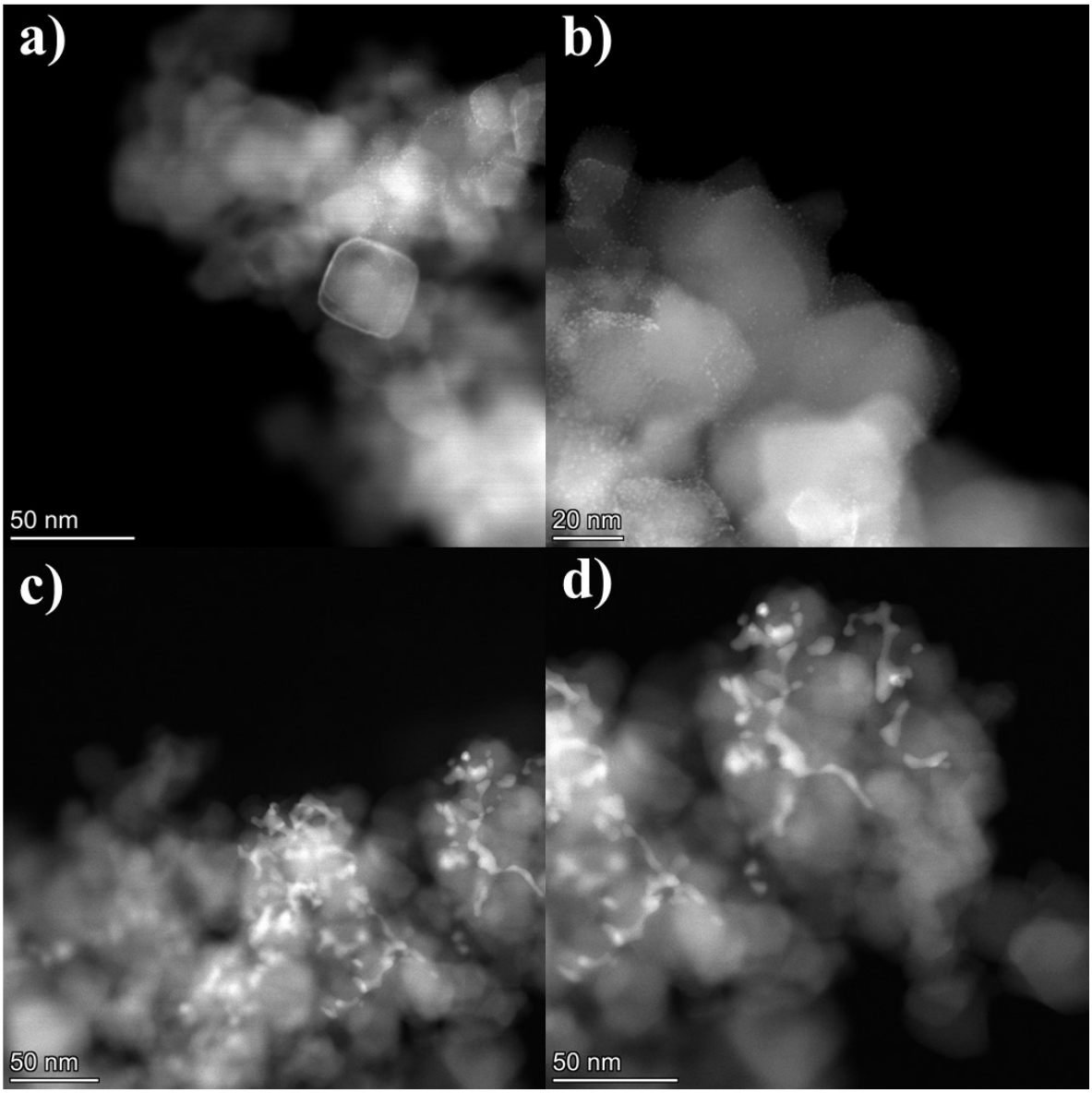


Figure S5: *Ti(2p) and O(1s) core-levels spectra for 0.6%Pt/TiO_2 series of catalysts (a) and the 4.2%Pt/TiO_2 series of catalysts (b)*

Table S2*: XPS data for the two Pt/TiO_2 catalysts after different heat treatments.*

Catalyst	*Heat Treatment*	B.E. / eV	*Pt species*	*Pt Concentration (%)*	*Total Pt concentration*
4.2%Pt/TiO_2	*Dried*	*72.7*	*Pt^{2+} (OH)*	*0.92*	*1.74*
		74.7	*PtClx*	*0.82*	
	Calcined	*72.7*	*Pt^{2+}*	*1.28*	*1.96*
		74.8	*$PtCl_x$*	*0.68*	
	Reduced	*70.5*	*Pt^0*	*0.14*	*0.14*
	Calcined+reduced	*70.9*	*Pt^0*	*1.24*	*1.24*
0.6%Pt/TiO_2	*Dried only*	*72.5*	*Pt^{2+}*	*0.28*	*0.28*
	Reduced only	*70.7*	*Pt^0*	*0.15*	*0.15*
	Calcined +reduced	*70.6*	*Pt^0*	*0.24*	*0.24*


a)
50 nm
b)
20 nm
c)
50 nm
d)
50 nm

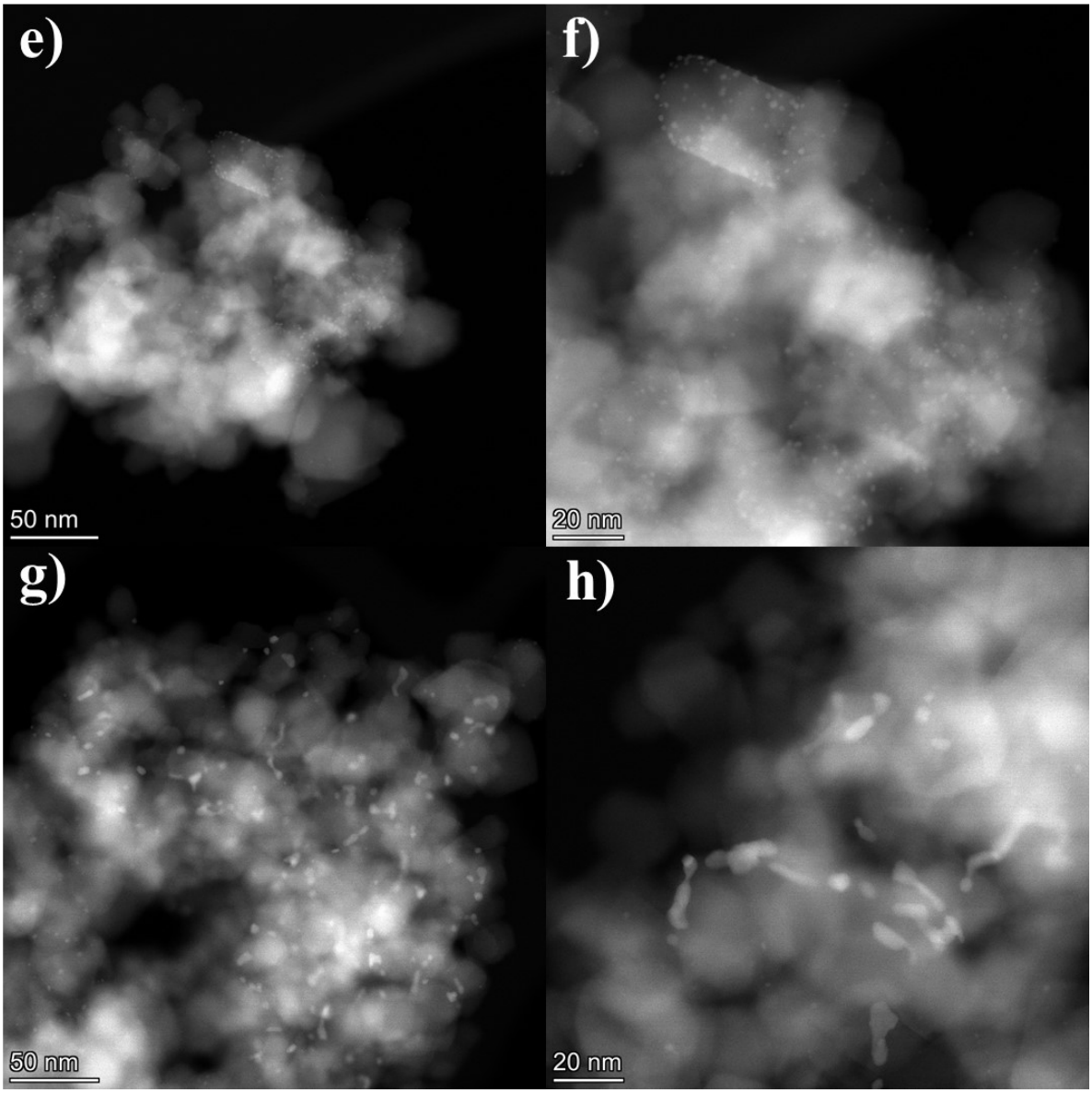


Figure S6: *Scanning Transmission Electron microscopic images of 4.2%Pt/TiO_2 (C+R) (a & b); 4.2%Pt/TiO_2 (R) (c & d); 0.6%Pt/TiO_2 (C+R) (e & f); 0.6%Pt/TiO_2 (R) (g & h). The lower magnification images highlight the presence of large irregular Pt particles on the reduced only catalysts.*

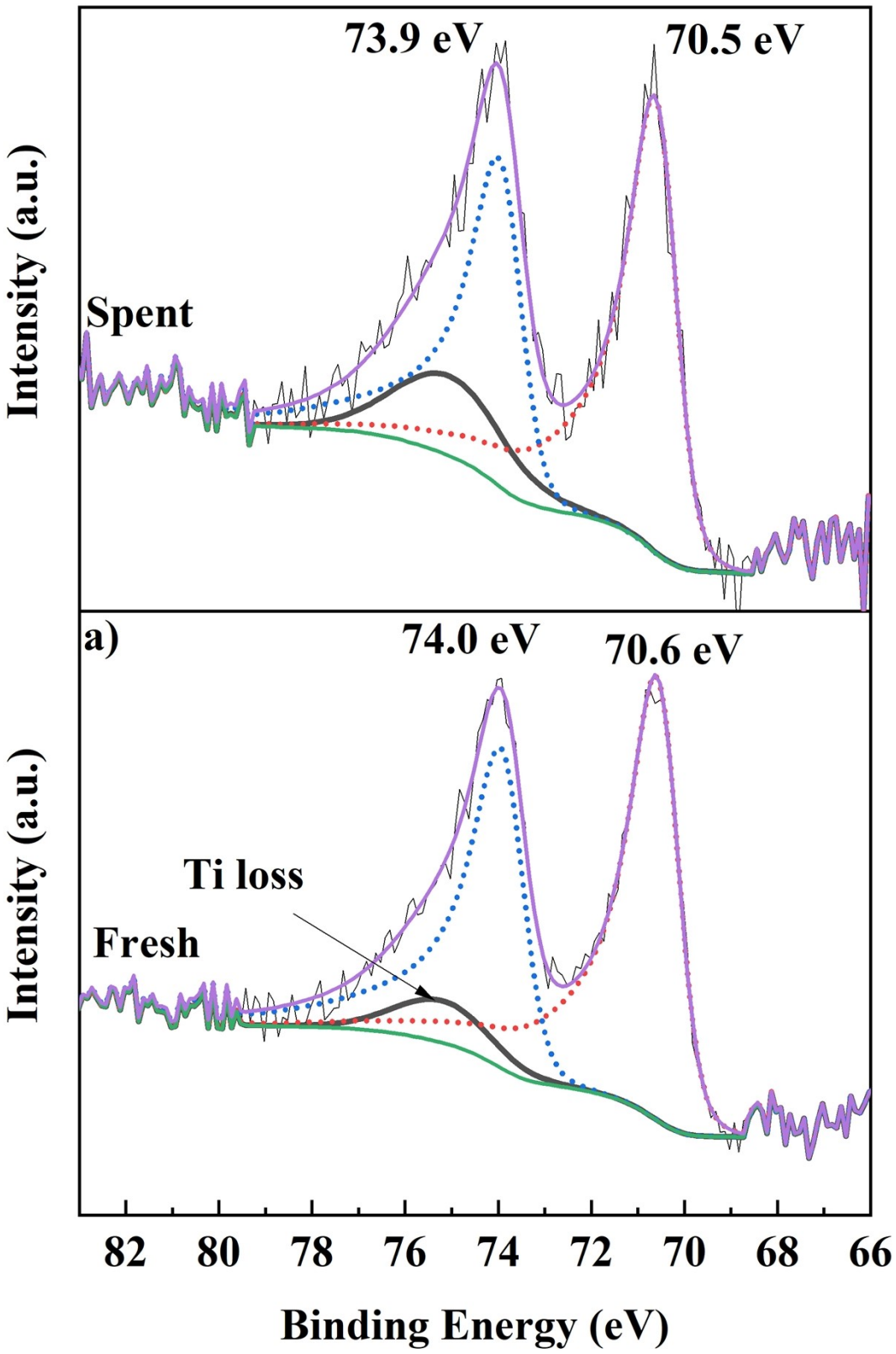
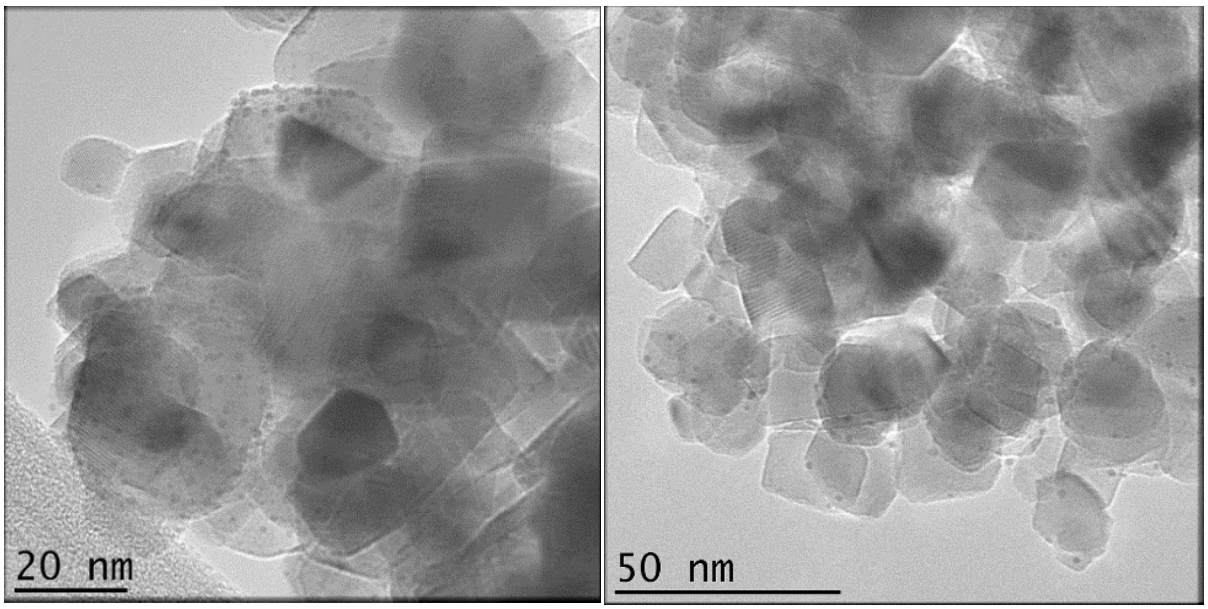


Figure S7 *XPS results of the fresh and spent samples of 0.6% Pt/TiO_2 calc +red*

Table S3: Quantitative analyses of the metal composition using Inductively Coupled Plasma coupled with Mass Spectra (ICP-MS)

Sample	**Pt (mg/g)**
0.6%Pt/TiO_2 - Fresh sample	8.77
0.6%Pt/TiO_2 - Spent sample after 3 runs	8.92



a) ***b)***

Figure S8: *TEM images of fresh (a) and spent (b) samples of 0.6 wt. % Pt/TiO_2 catalyst.* .

Table S4: *Comparison of different supported Pt nanoparticulate catalysts for the hydrogenation of FF to 2-FF including the current work.*

Catalyst	**Preparation method**	**Catalyst & FF**	**Temp./Press./Solvent/Time**	**Conv. (%)**	**Selec. (%)**	**Ref**
3% Pt/HT	Wetness impregnation	FF (0.75 mmols), catalyst (50 mg)	30 ºC, /15 bar/ water/ 2 h	99	99	[1]
3% Pt/SiC–C	Ultrasound promoted impregnation	FF (0.3 ml), catalyst (20 mg),	25 ºC/ 10 bar/ water/ 5h	99	99	[2]
2.3% Pt/MgO,	Colloidal deposition	FF (0.02 mmols) , catalyst (20 mg)	50 ºC/1.03 bar /methanol/ 7 h	80	99	[3]
1.4% Pt/CeO_2	Colloidal deposition	FF (0.02 mmols) , catalyst (20 mg)	50 ºC/ 1.03 bar /methanol/ 7 h	79	97	[3]
1.9% Pt/γ-Al_2O_3	Colloidal deposition	FF (0.02 mmols) , catalyst (20 mg)	50 ºC/ 1.03 bar /methanol/ 7 h	77	98	[3]
5% Pt/TiO_2 nanorod (NR)	Impregnation–chemical reduction	FF (26 mmol), catalyst (100 mg)	170 ºC/20 bar/ water/ 2 h.	90	2	[4]
0.7% Pt/TiO_2	One-step flame spray pyrolysis (FSP)	FF (0.05 ml), catalyst (50 mg)	50 ºC/ 20 bar/ methanol/ 2 h.	83	95	[5]
0.5% Pt/TiO_2	Strong electrostatic adsorption method (SEA)	FF (0.6 mmol), catalyst (50 mg)	50 ºC/ 20 bar/ methanol/ 2 h.	89	80	[6]
1% Pt/$SnNb_2O_6$	Photoreduction method	FF (0.1 mmol), catalyst (8 mg)	25 ºC/ 1 bar/ methanol/ 2 h.	99.9	99.9	[7]
1% Pt/Al_2O_3	Incipient wetness impregnation	FF (0.3 mmol),	150 ºC/ 5 bar/ isopropanol/ 5 h.	95	98	[8]

		catalyst (58 mg)				
Pt/CeO2/UIO	Deposition method	FF (0.2 mmol), catalyst (Pt: 0.5 mol %)	80 ºC/ 10 bar/ isopropanol/ 30 h.	100	99	[9]
0.6% Pt/TiO_2	Wetness impregnation	FF (0.3 ml), catalyst (100 mg),	30 ºC/ 3 bar /isopropanol/ 6 h	97	95	Current work

Supplementary References

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