Supplementary Information

Crystalline niobium phosphates with water-tolerant Lewis acid sites for the production of lactic acid from triose sugars

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Fig. S2 FTIR spectra of (a) $SnO_2/NbOPO_4$-P123, (b) $SnO_2/NbOPO_4$-F127, and (c) $SnO_2/NbOPO_4$-SDBS after pyridine sorption and evacuation at various temperatures.

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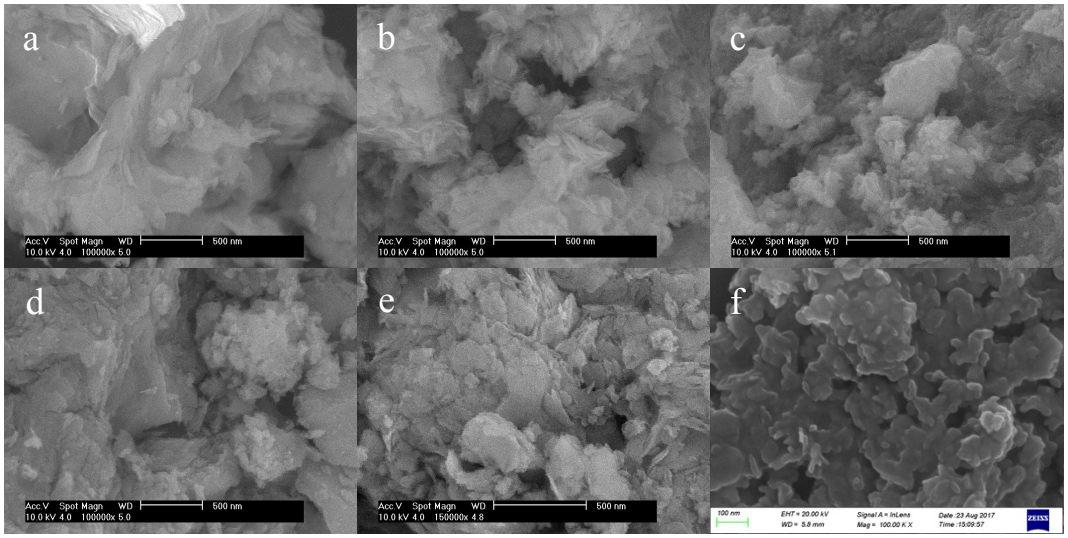
Fig. S8 Consecutive outgassing of fresh $SnO_2/NbOPO_4$-CTAB at 150 °C, followed by steaming and further outgassing (As a supplementary to Fig. 7).

Table S1 The concentration of BrØnsted and Lewis acid sites of $SnO_2/NbOPO_4$ catalysts.

Table S2 Catalytic activities of $NbOPO_4$-P123 and $SnO_2/NbOPO_4$-F127 for sugars dehydration in water



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It could be concluded that the addition of CTAB tend to split the bulk catalyst into crystalline pieces. And the doping of SnO_2 made the surface of the bulk $NbOPO_4$ catalysts into smaller particles compared with the pure $NbOPO_4$, thus leading to relatively higher specific surface areas. However, the decrease of specific surface area of CTAB modified $SnO_2/NbOPO_4$ might result from the crystallinity of tin oxide and niobium phosphate species as shown in Fig. S1f.

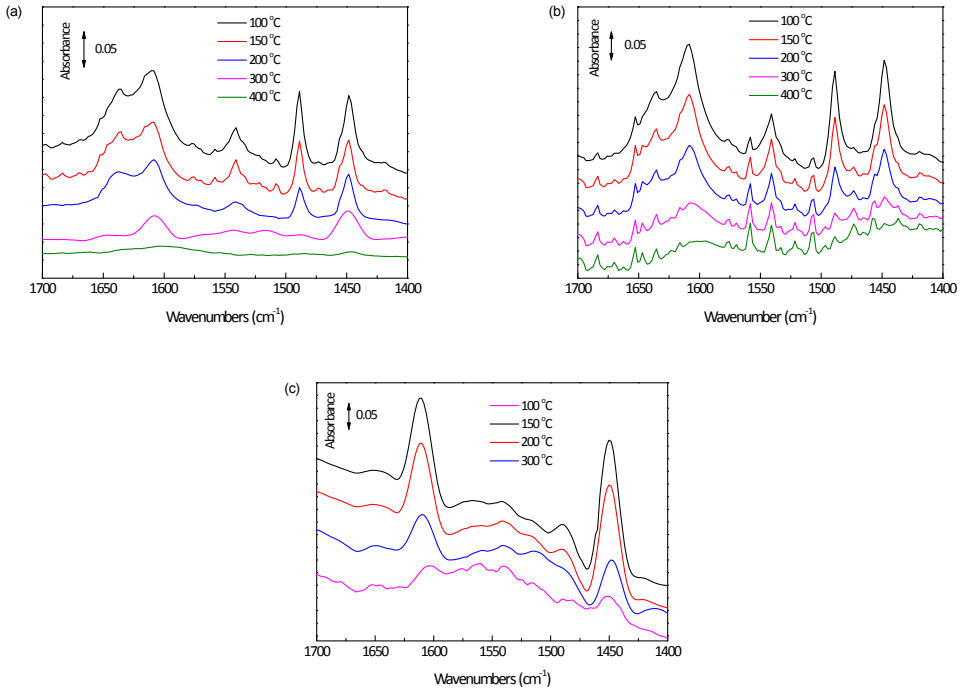
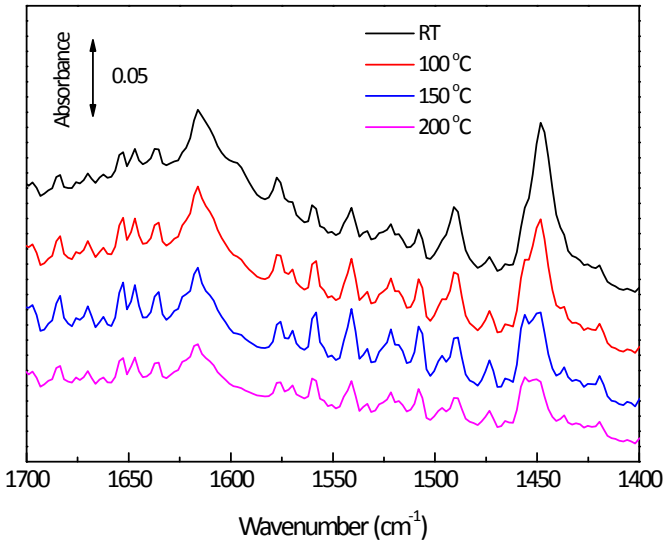


Fig. S2 FTIR spectra of (a) SnO_2/$NbOPO_4$-P123, (b) SnO_2/$NbOPO_4$-F127, and (c) SnO_2/$NbOPO_4$-SDBS after pyridine sorption and evacuation at various temperatures.



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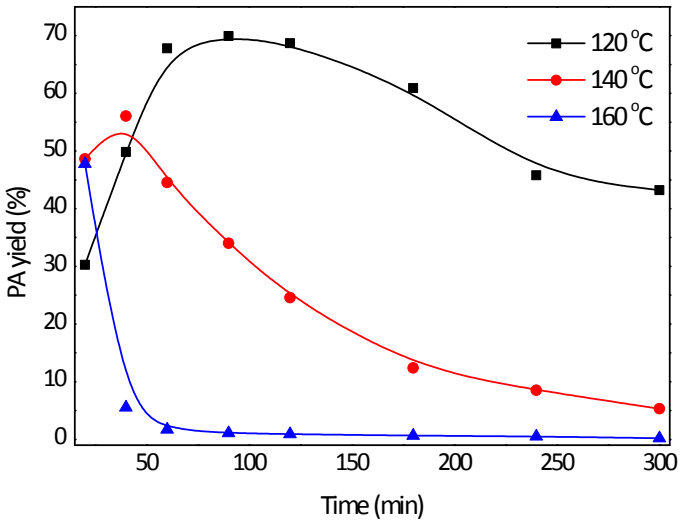

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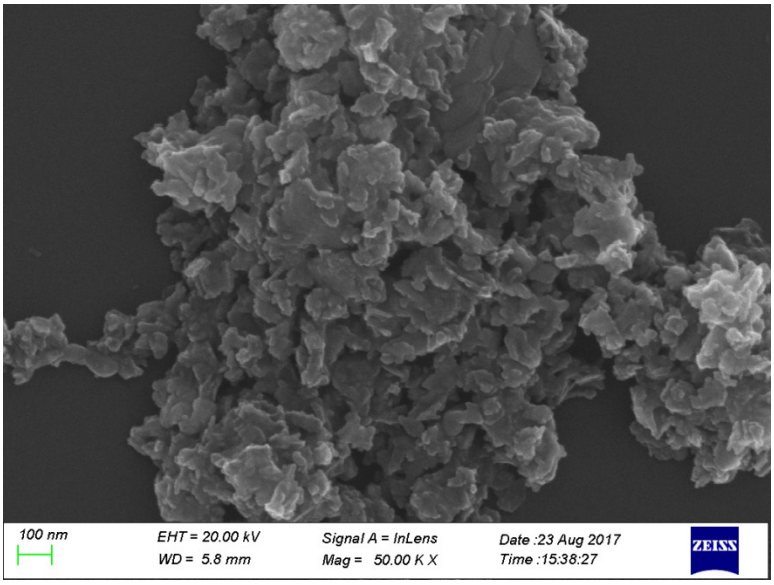

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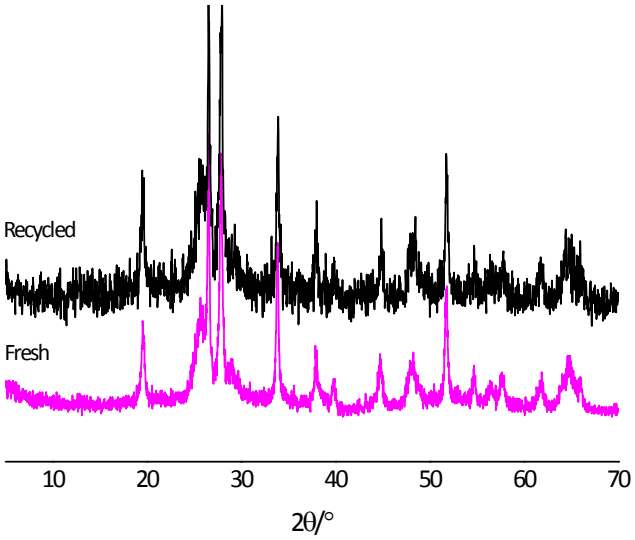

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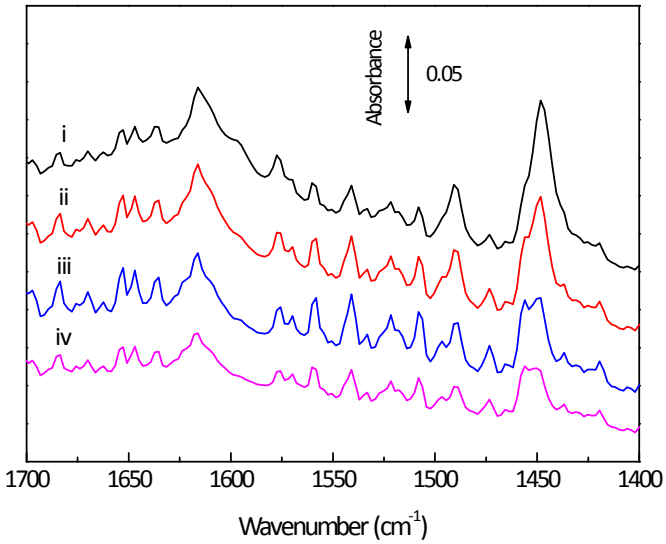

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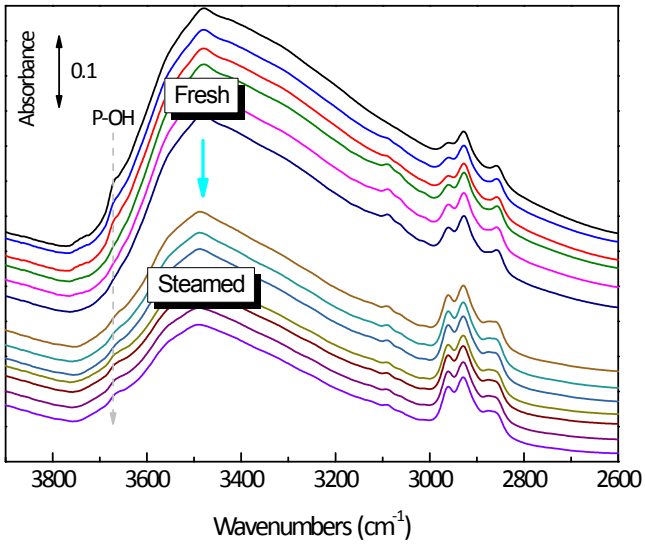

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Table S1 The concentration of BrØnsted and Lewis acid sites of $SnO_2/NbOPO_4$ catalysts.

Entry	Catalysts	BrØnsted acid sites (mmol g^{-1})	Lewis acid sites (mmol g^{-1})
1	$SnO_2/NbOPO_4$	0.113	0.407
2	$SnO_2/NbOPO_4$-P123	0.096	0.214
3	$SnO_2/NbOPO_4$-F127	0.068	0.142
4	$SnO_2/NbOPO_4$-SDBS	0.05	0.20
5	$SnO_2/NbOPO_4$-CTAB	-	0.27

Table S2 Catalytic activities of $NbOPO_4$-P123 and $SnO_2/NbOPO_4$-F127 for sugars dehydration in water[a]

Entry	Substrate	$SnO_2/NbOPO_4$-P123			$SnO_2/NbOPO_4$-F127			$SnO_2/NbOPO_4$-SDBS		
		Conv. (%)	5-HMF	Furfural	Conv. (%)	5-HMF	Furfural	Conv. (%)	5-HMF	Furfural
1	Sucrose	50.3	3.7	4.2	57.5	4.3	4.3	53.2	4.8	3.9
2	Glucose	85.2	14.5	4.1	82.5	15.0	4.1	86.7	13.9	2.8
3	Xylose	88.5	-	29.0	86.8	-	23.4	87.5	-	24.1
4	Maltose	63.7	12.2	0.1	60.9	10.8	0.1	66.2	12.2	0.1
5	Fructose	90.5	24.2	4.4	87.2	19.2	4.1	88.2	20.5	3.1

[a] Reaction conditions: 60 mg sugars, 3 mL water, 30 mg catalyst, T=413 K, t= 1h.