Fabrication of micellar heteropolyacid with Lewis-Brønsted acid sites and application for the production of 5-hydroxymethylfurfural from saccharides in water

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Supporting information

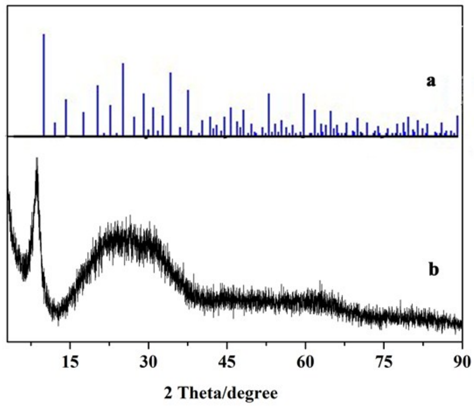


Fig. S1. XRD patterns of (a) $H_3PW_{12}O_{40}$ and (b) $(C_{16}TA)H_4PW_{11}Ti$

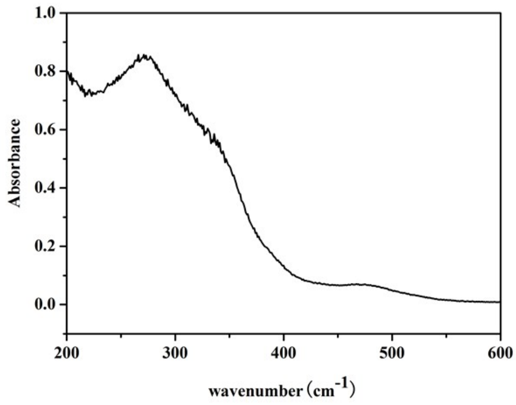


Fig. S2. The UV–vis pattern of $(C_{16}TA)H_4PW_{11}Ti$

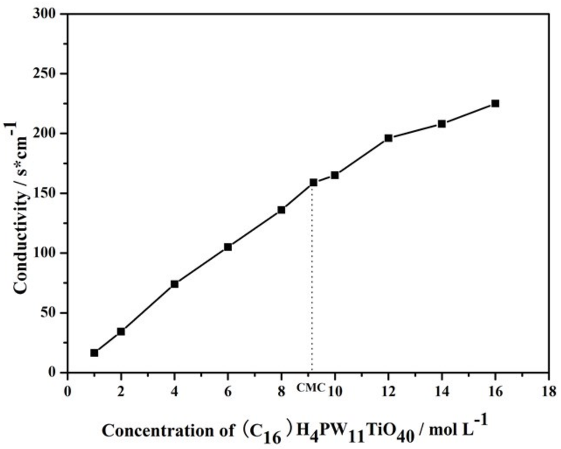


Fig. S3. The conductivity of $(C_{16})H_4PW_{11}Ti$ at the room temperature.

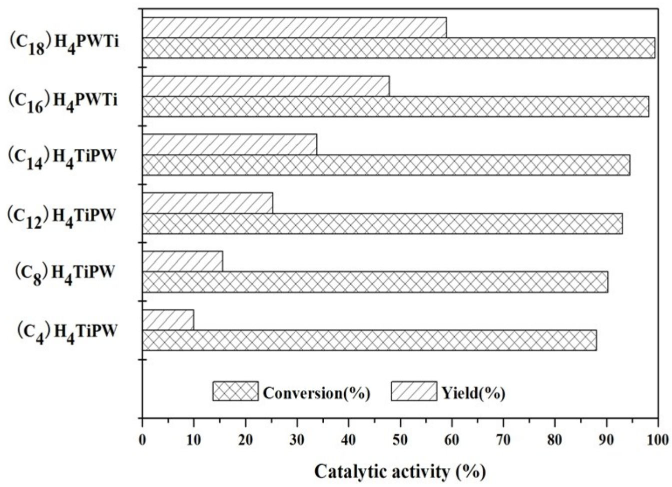
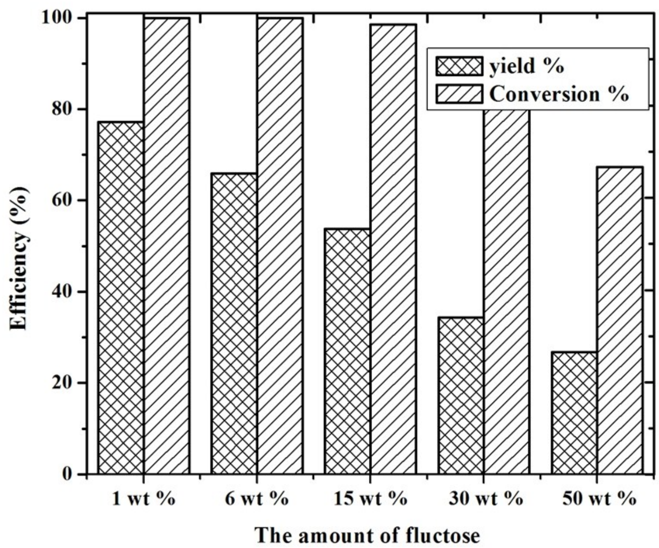


Fig. S4. The influence of the carbon chain length on the conversion of fructose into HMF. Reaction conditions: 0.6 g of fructose, 0.01 mmol of catalyst, 2 mL of water, 130 °C for 90 min.



Efficiency (%)
100
80
60
40
20
0
yield %
Conversion %
1 wt %
6 wt %
15 wt %
30 wt %
50 wt %
The amount of fluctose

Fig. S5. The influence of the amount of fructose on the conversion. Reaction conditions: 0.01 mmol of catalyst, 2 mL of water, 130 °C for 30 min.

Table S1 The comparison between different catalysts on dehydration of glucose to HMF

Catalysts	System	Concentration (wt%)	T(ºC)	time	Yield(%)	Con.(%)	Ref
NbPO-pH 2	water	5	140ºC	60min	14.1	24.4	1
NbPO-pH 7	water	5	140ºC	60min	33.6	68.1	1
HCl	$C_{12}MI.Cl$	10	120ºC	8min	30	79	2
HCl	$C_{12}MI.Cl$	10	120ºC	12min	34	75	2
InCl3	water	5	180ºC	5min	52.0	81.9	3
InCl3	water	5	180ºC	10min	59.8	91.4	3
InCl3	NaCl-H_2O/THF	4.5	200ºC	2h	50.9	99	4
$CrCl_3 \cdot 6H_2O$	water	5	110ºC	30min	10.5	12.0	5
Hβ-zeolite	[BMIM]Cl	10	150ºC	50min	50.3	80.6	6
$InCl_3$	water	5	180ºC	10min	59.8	91.4	7

SO_4/ZrO_2	water	-	100 ºC	6h	1.0	20.9	8
Beta-ST600	Water/DMSO	3	180ºC	3h	43	78	9
Sn-MCM-41(50)	[EMIM]Br	10	110ºC	4h	70	99	10
SO_4^{2-}/ZrO_2-TiO_2	n-butanol/water	6	170ºC	2h	26.0	96.5	11
phosphate/TiO_2	Water/THF	10	120 ºC	2h	81.2	98	12
IL-5	Water/MIBK	30	120 ºC	6h	78.4	99.8	13
TiHP	water-NaCl/THF	25	140 ºC	3h	17	29	14
Zr-MCM-550	Water/MIBK	10	175 ºC	2.5h	23	82	15
$CrCl_2$-Im-SBA-15	Water/DMSO	10	100 ºC	3h	35	51	16
Mesoporous tantalum phosphate	Water/MIBK	10	170 ºC	1h	32.8	56.3	17
Mesoporous tantalum oxide	Water/MIBK	10	175 ºC	90min	23	69	18
ZrP	Water/diglyme	10	180 ºC	3h	63		19
TiO_2	Water	2	140 ºC	6h	30	80	20
$CrCl_3$	Et-DBUBS	10	100 ºC	3h	78.6	93	21
ZrSil /Amberlyst-15	THF/H_2O	5	180 ºC	1.5h	39	87	22
K-10 clay-$CrCl_3$	[BMIM]Cl	4.5	120 ºC	2h	56.3		23
$AlCl_3$/NaI	DMAC	4.5	130 ºC	15min	62	86	24
H_3PO_4/ NaH_2PO_4	Water	10	160 ºC	90min	39.5	83.2	25
Amberlyst-70 resin	DMSO	7.6	140 ºC	24h	32.0	98.1	26
[C_3SO_3HMIM][HSO_4]/ $CoCl_2$	[AMIM]Cl	9	120 ºC	2h	62.2	95.5	27
H_3BO_3/SiO_2	[bmim]HSO_4	10	120 ºC	3h	81		28
$H_3PO_4/Nb_2O_5\cdot nH_2O$	Water	1	120 ºC	3h	47.9	92	29
P-VI-0/P-SO_3H-154	THF/DMSO	2	100 ºC	10h	95.4		30

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