Electronic Supplementary Information (ESI)

Bifunctional heterogeneous catalysts derived from the coordination of adenosine monophosphate to Sn(IV) for effective conversion of sucrose to 5-hydroxymethylfurfural

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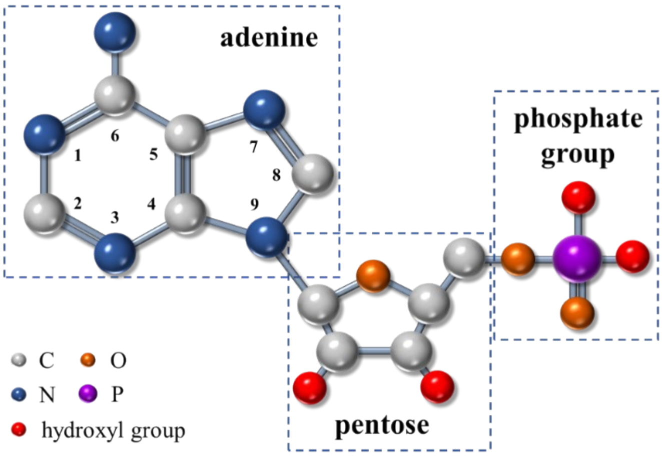

Scheme S1. Molecular structure of adenosine monophosphate.

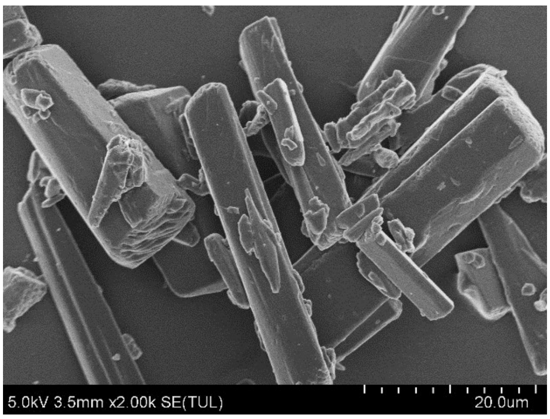

Figure S1. SEM image of AMP.

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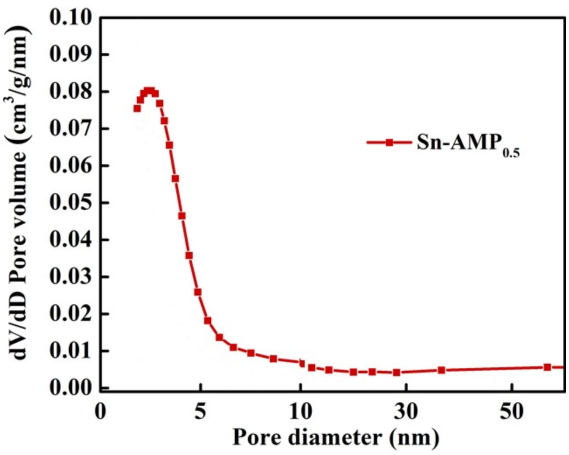

Figure S2. Pore size distribution of Sn-AMP$_{0.5}$.

Figure S3 shows the Raman spectra for fresh Sn-AMP$_{0.5}$ and Sn-AMP$_{0.5}$ after interacting with glucose (Sn-AMP$_{0.5}$+glucose) and with fructose (Sn-AMP$_{0.5}$+fructose). The peaks at 1318 and 1424 cm^{-1} are attributed to the adenine ring breathing mode.[S1,S2] The peaks at 1340 and 1404 cm^{-1} are attributed to the sugar stretching mode.[S1,S2] The interactions of glucose and fructose with Sn-AMP$_{0.5}$ resulted in the intensity changes of these peaks. The peaks at 965 and 1015 cm^{-1} of fresh Sn-AMP$_{0.5}$ are attributed to OH-P and N1-C6.[S1,S2] These peaks did not appear in the spectra of Sn-AMP$_{0.5}$+glucose and Sn-AMP$_{0.5}$+fructose, attributed the interactions of glucose and fructose with the phosphate and N1 of AMP. The Raman spectra can prove the hydrogen bonding interactions of glucose and fructose with Sn-AMP$_{0.5}$.

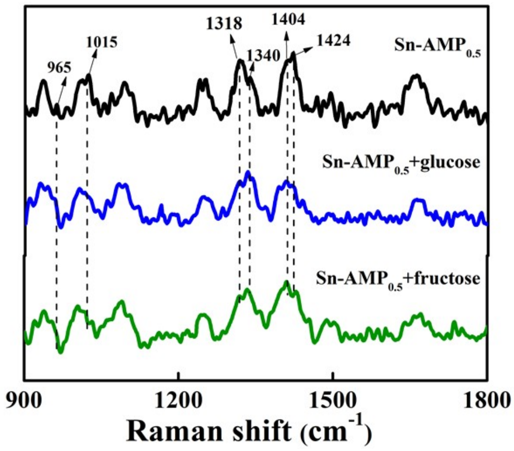

Figure S3. Raman spectra in the region of 900-1800 cm^{-1} for fresh Sn-AMP$_{0.50}$ (black), Sn-AMP$_{0.5}$ after interacting with glucose (blue), and Sn-AMP$_{0.5}$ after interacting with fructose (oliver).

Raman spectra were recorded using a Raman microscope (Kaiser Optical Systems, Inc., Ann Arbor, MI, USA) with 785 nm laser excitation.

Table S1. FTIR spectra data of AMP and Sn-AMP$_{0.5}$.

	AMP (cm^{-1})	Sn-AMP (cm^{-1})
NH_2- scissor mode	1695	1695
NH_2- bending mode	1650	1650
C4-C5 skeletal vibrations	1595	—
pyrimidine ring vibration	1557	1548
imidazole	1504	1514
N7-C8	1463	1463
C6-N1	1421	1421
pyrimidine	1385	1407
C6-NH_2 deformation	1280	—
	1198	
ribose C-O stretching vibration	1102	
	1036	
P-O-H vibration	1062,985	

Table S2. During the synthesis process for the Sn-AMP samples, the pH of the solutions after hydrothermal treatment.

	Sn-AMP $_{0.125}$	Sn-AMP $_{0.25}$	Sn-AMP $_{0.5}$	Sn-AMP $_{0.75}$
pH	1.29	1.34	1.40	1.56

Table S3. Comparison of catalytic activity of Sn-AMP catalysts for dehydration of glucose.

Entry	Catalyst	X (%)	Y_{HMF} (%)	$Y_{fructose}$ (%)	Y_{FA} (%)
1	Sn-AMP$_{0.125}$	95.7	54.0	4.2	1.8
2	Sn-AMP$_{0.25}$	96.8	62.1	5.0	2.1
3	Sn-AMP$_{0.5}$	96.4	63.5	4.1	2.0
4	Sn-AMP$_{0.75}$	97.1	56.4	3.1	2.2

Reaction condition: glucose (200 mg), Sn-AMP (50 mg), 5 mL of solvent, water/THF (v:v 1:4), 160 °C, 5h.

Table S4. Comparison of Sn-AMP with other catalysts. (Yield: HMF yield, Sel.: HMF selectivity)

saccharide	Solvent	Catalyst	T/°C	t/h	Yield	Sel.	Ref.
ucrose	water/DMSO/HCL	Sn-CP	170	4	61.6%	≥64.8%	S3
glucose			170	4	63.9%	65.4%	
sucrose	water/THF/NaCl	Sn-Mont	160	3	43.6%	-	S4
glucose					41.7%	-	
sucrose	water/Dioxane	Sn-β/Amberlyst-131	90	10	60.0%	-	S5
glucose				16	56.0%	-	
sucrose	water/THF/NaCl	Phosphated TiO_2	175	2	43.0%	45.3%	S6
glucose				4	53.5%	54.3%	
sucrose	water /GVL/NaCl	APG-SO_3H	180	4	56.2%	-	S7
glucose					52.9%	-	
sucrose	water/THF	[MimAM]nH3-n$PW_{12}O_{40}$	160	7.5	23.5%	24.9%	S8
glucose					39.2%	39.5%	
sucrose	water/THF	Sn-AMP$_{0.5}$	160	4.5	62.9%	63.0%	This work
glucose	water/THF		160	5	67.5%	69.6%	

References

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