Supporting Information

A biomass-derived metal-free catalyst doped with phosphorus for highly efficient and selective oxidation of furfural into maleic acid

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Catalyst characterization

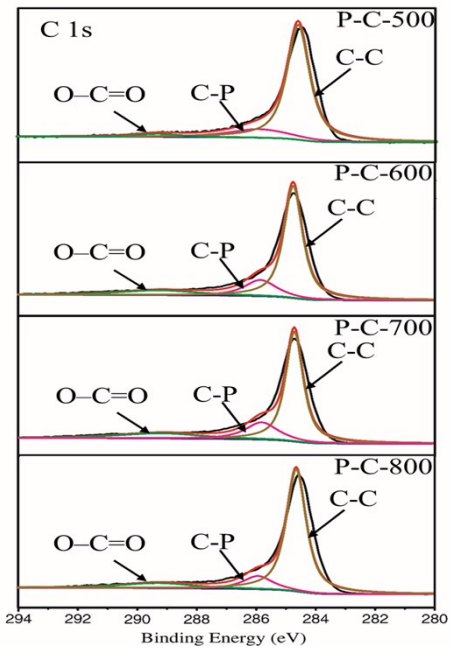

Fig. S1. XPS C1 s spectra of P-CT carbon samples synthesized with different annealing temperature.

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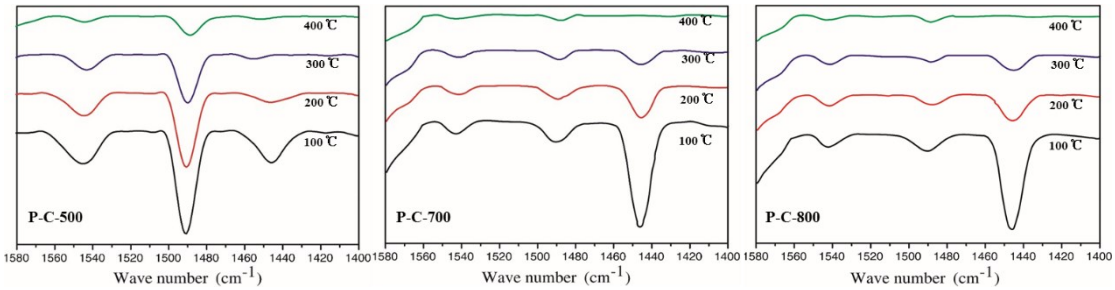

Fig. S2 Py-IR spectra of P-C-T catalysts

Table S1 Summarized acid distribution on the P-C-T catalysts

Catalyst	Acid sites (mmol Py/gcat)								
	Weak		Medium		Strong		Total		Total
	B	L	B	L	B	L	B	L	B+L
P-C-500	0.04	0.04	0.11	0.04	0.01	0.00	0.16	0.08	0.24
P-C-600	0.02	0.11	0.02	0.07	0.01	0.00	0.04	0.18	0.23
P-C-700	0.03	0.13	0.02	0.03	0.01	0.00	0.06	0.16	0.22
P-C-800	0.03	0.11	0.03	0.04	0.01	0.00	0.06	0.14	0.20

Estimated by Py-IR spectra of pyridine adsorption analysis

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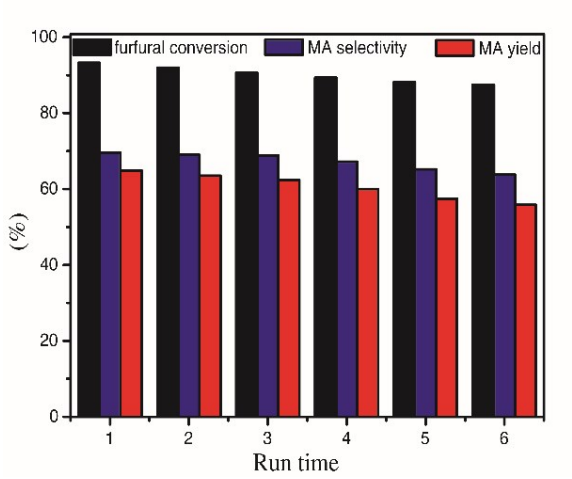

Fig. S3 Cycle usage of P-C-600 catalyst
Reaction conditions: 60 °C, 6 h
The loading of catalyst is lower than the usage in the manuscript

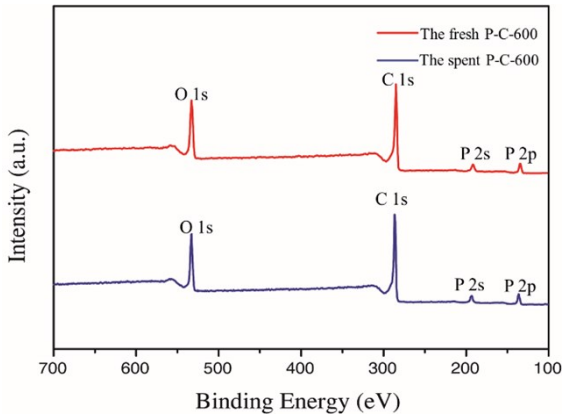

Fig. S4. XPS scan spectra of the spent P-C-600

Table S2 XPS analysis on element contents of the spent P-C-600.

Entry	Catalyst	Total%			Calculated %	
		C (at.%)	P (at.%)	O (at.%)	P-C (at.%)	P-O (at.%)
1	The spent P-C-600	73.6	5.77	20.63	0.19	5.58

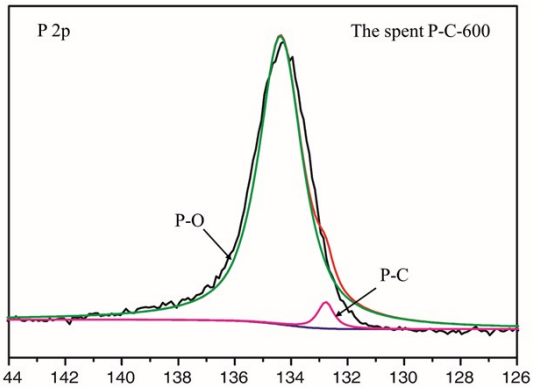

Fig. S5. XPS high-resolution P 2p spectra of the spent P-C-600

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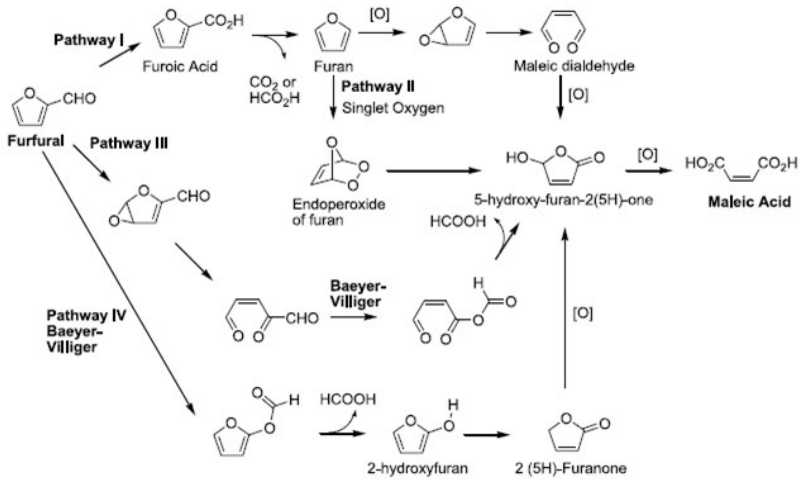
Reaction Pathways for H2O2 Oxidation of Furfural to Maleic Acid



Scheme S1. The oxidation of furfural to maleic acid via four different routes (Lou, Y.; Marinkovic, S.; Estrine, B.; Qiang, W.; Enderlin, G., Oxidation of Furfural and Furan Derivatives to Maleic Acid in the Presence of a Simple Catalyst System Based on Acetic Acid and TS-1 and Hydrogen Peroxide. ACS Omega 2020, 5 (6), 2561-2568.).

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