Electronic Supplementary Material (ESI) for Green Chemistry.

Biomass-Derived Phosphorus-Doped Carbon Materials as Efficient Metal-Free Catalysts for Selective Aerobic Oxidation of Alcohols

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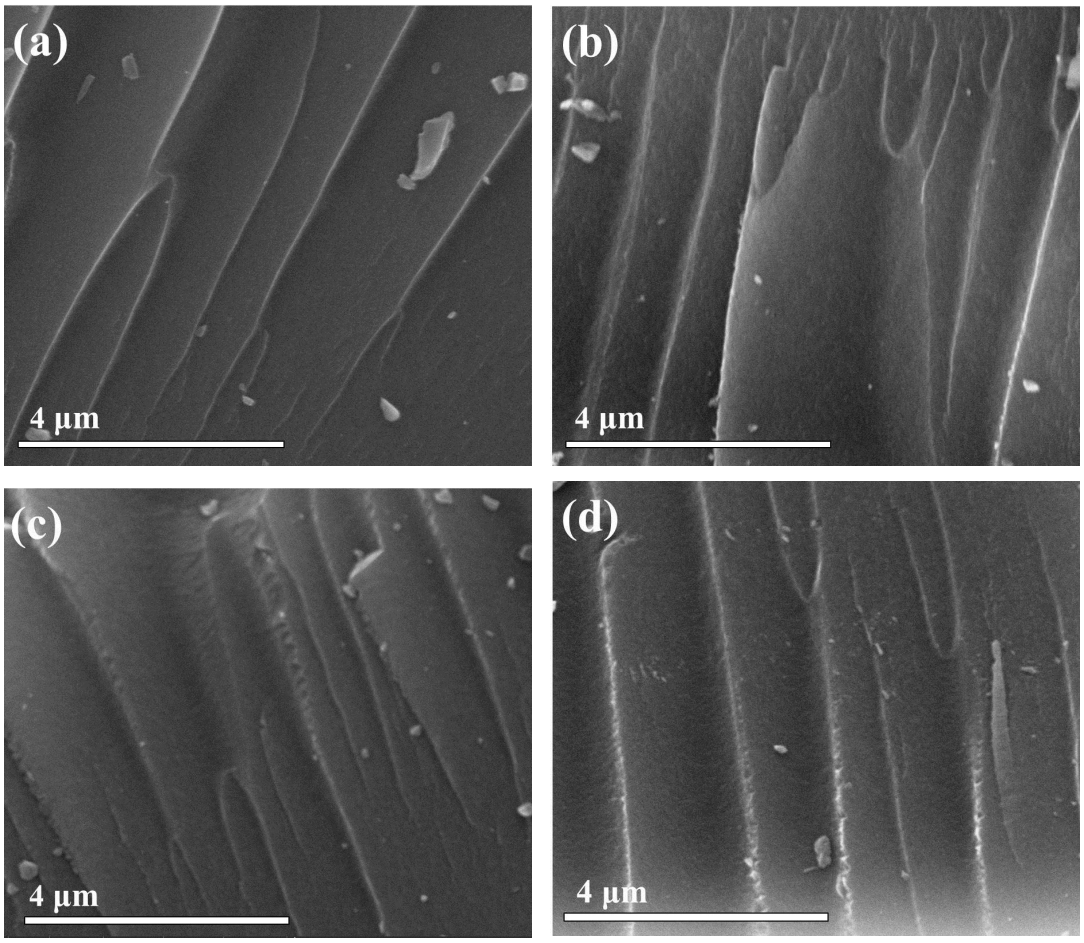


Fig. S1. SEM images of PC-500 (a), PC-600 (b), PC-700 (c) and PC-800 catalysts (d).

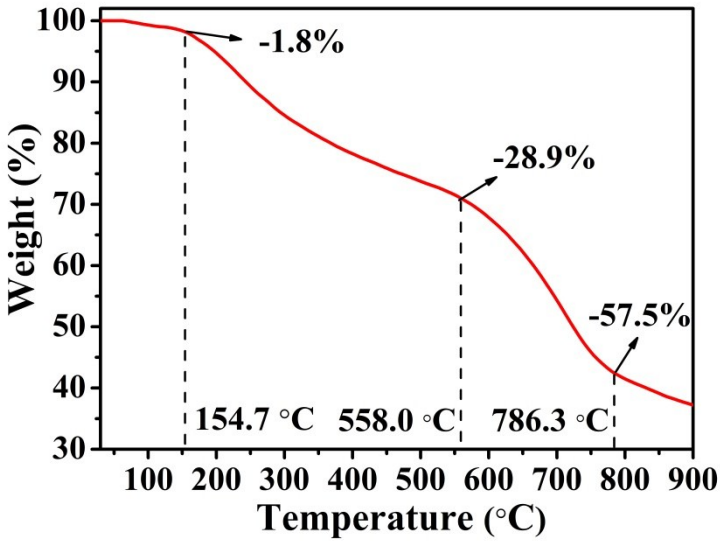


Fig. S2. TGA curve of PC.

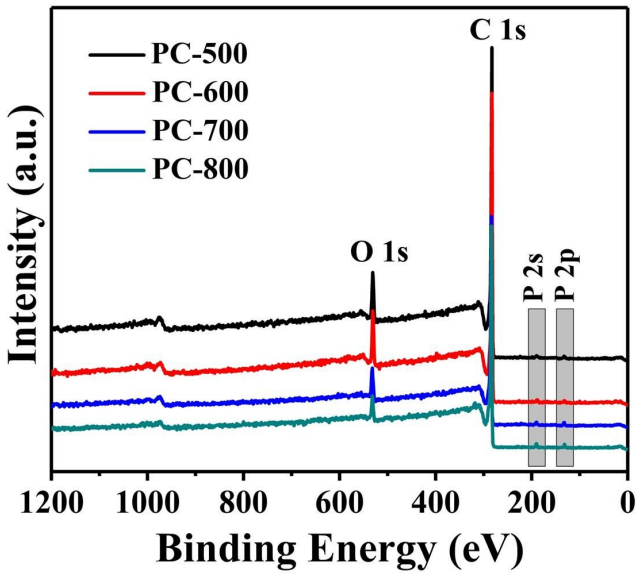


Fig. S3. The wide scan spectra of PC-500, PC-600, PC-700 and PC-800 catalysts.

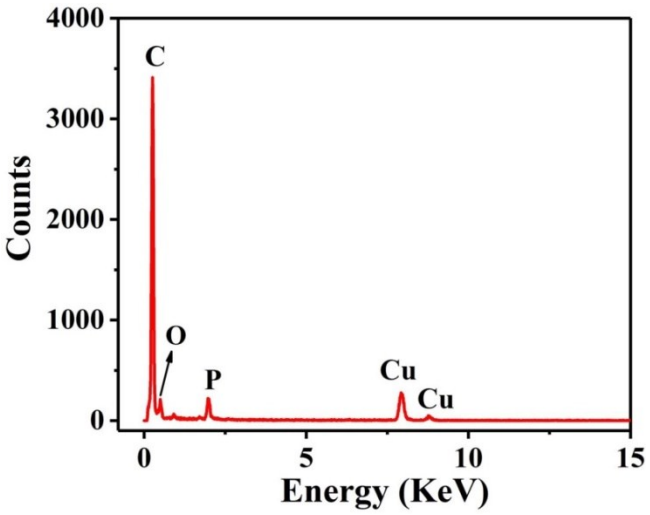


Fig. S4. The EDX spectrum of PC-700 catalyst.

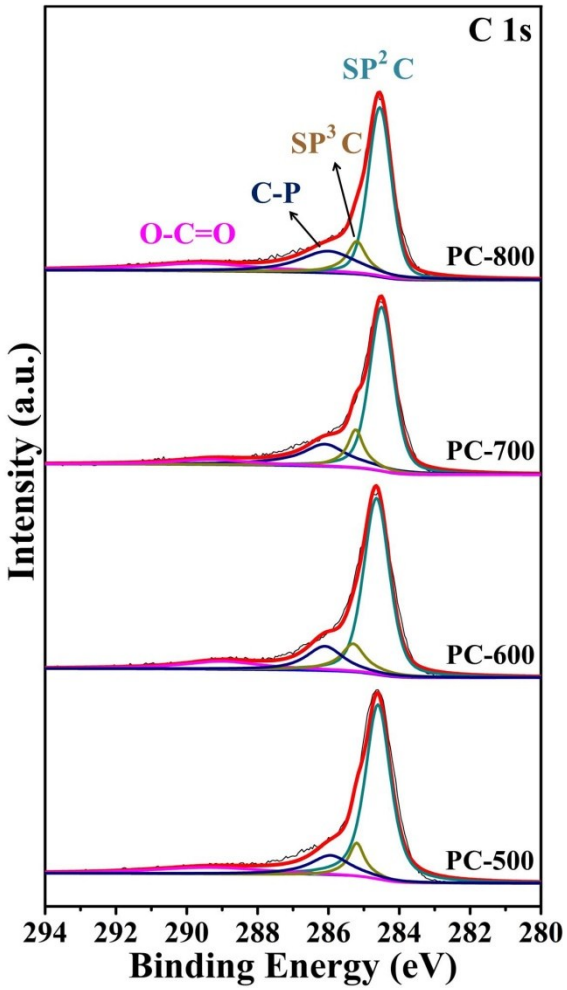


Fig. S5. XPS C 1s spectra of PC-X catalysts, i.e., PC-500, PC-600, PC-700 and PC-800, respectively.

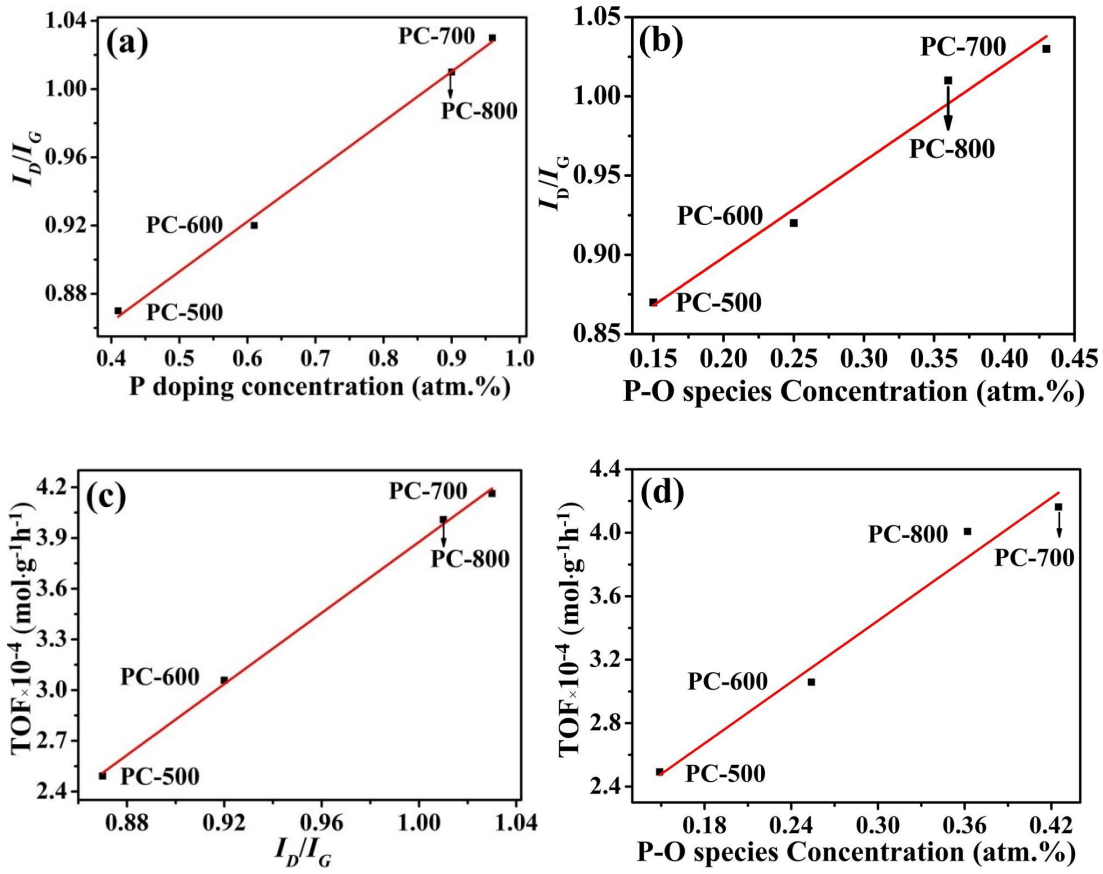


Fig.S6. (a) Linear correlation between the P doping concentration and the values of I_D/I_G. (b) Linear correlation between the P-O species concentration and the values of I_D/I_G (c) Linear correlation between the values of I_D/I_G and TOF values in aerobic oxidation of benzyl alcohol. (d) Linear correlation between the P-O species concentration and TOF values in aerobic oxidation of benzyl alcohol.

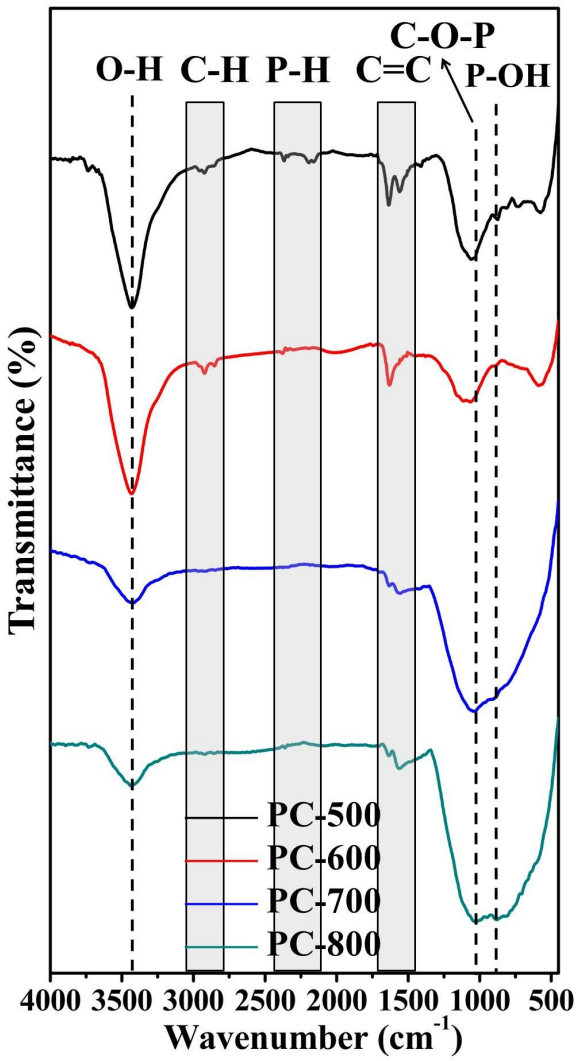


Fig.S7. The FT-IR spectra of PC-500, PC-600, PC-700 and PC-800 catalysts.

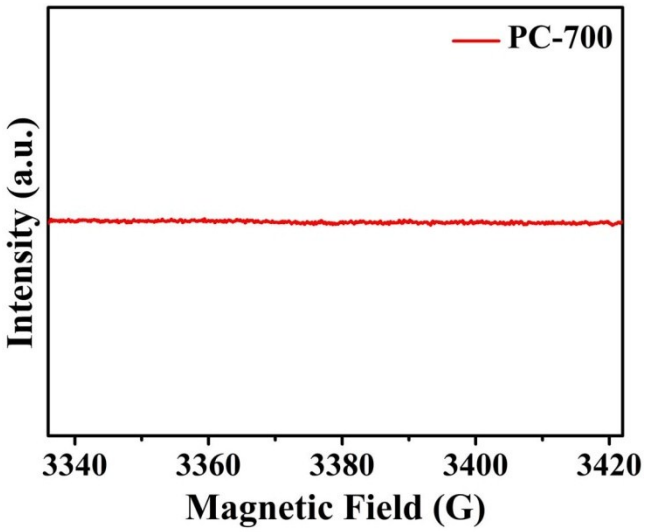


Fig.S8. EPR spectra of aerobic oxidation of benzyl alcohol catalyzed by PC-700 catalyst.

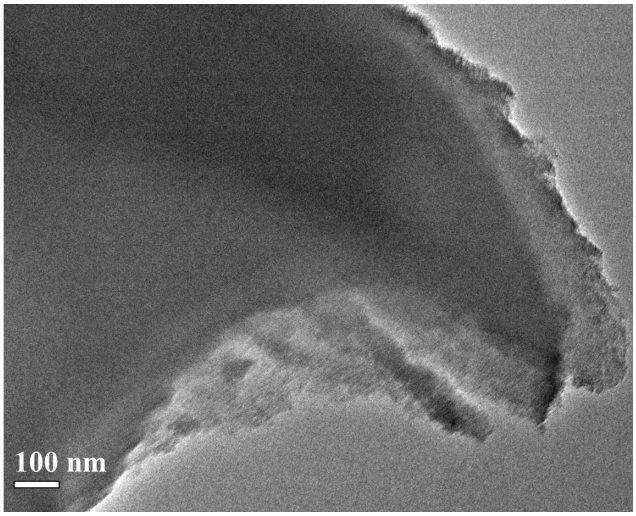


Fig. S9. TEM image of reused PC-700 catalyst.

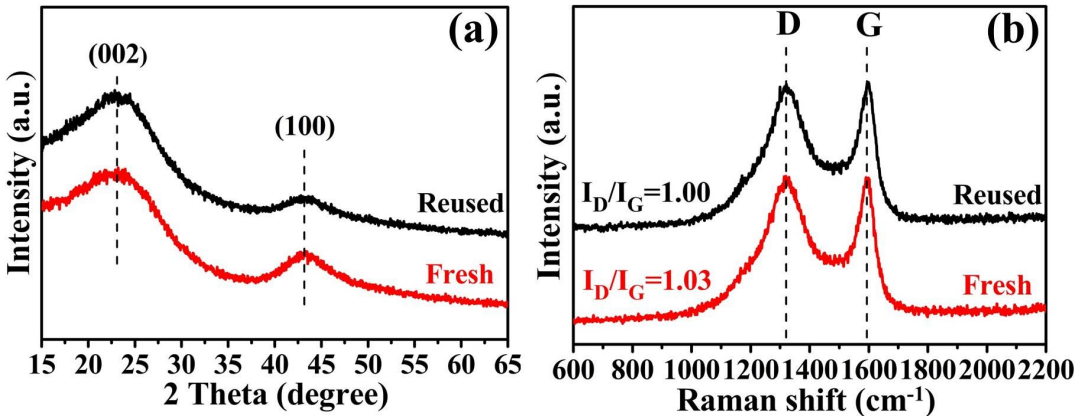
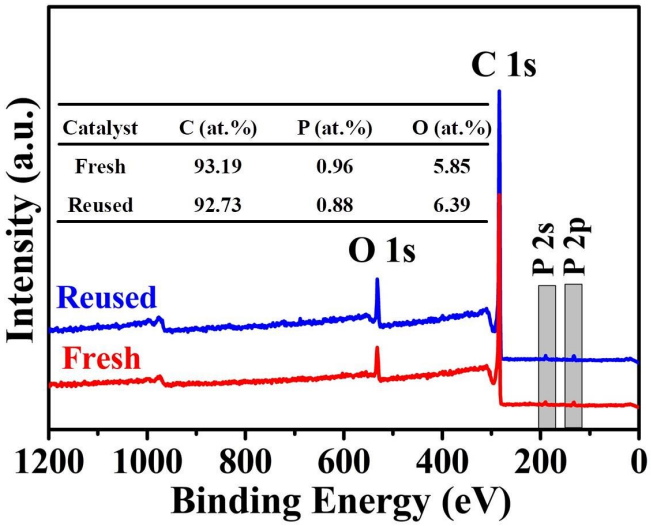


Fig. S10. The comparison between fresh and reused PC-700 catalyst in PXRD patterns (a) and Raman spectra (b).



Catalyst	C (at.%)	P (at.%)	O (at.%)
Fresh	93.19	0.96	5.85
Reused	92.73	0.88	6.39

Fig. S11. The comparison between fresh and reused PC-700 catalyst of the contents of C, O and P in XPS wide scan spectrum.

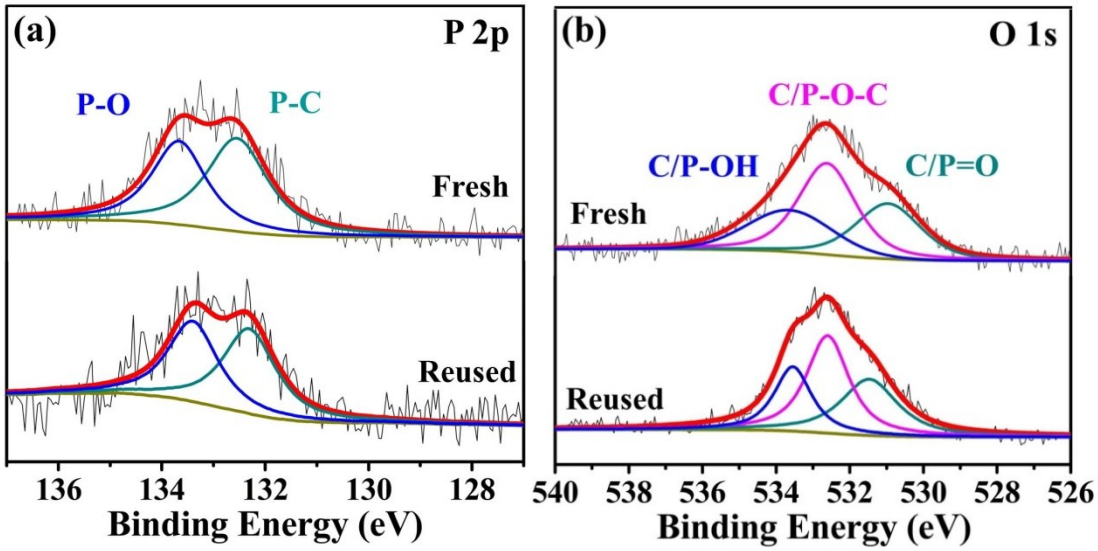


Fig. S12. The comparison between fresh and reused PC-700 catalyst in P 2p (a) and O 1s (b) spectra.

Table S1. Texture parameters of prepared PC catalysts and the comparison of catalytic performance in aerobic oxidation of benzyl alcohol.

Entry	Samples	BET surface area ($m^2 g^{-1}$)	Pore volume ($cm^3 g^{-1}$)	Average pore size (nm)	Yield/Sel. (%)	TOF ($mol \cdot g^{-1} h^{-1}$)[b]
1	PC-500	1627.3	0.87	2.13	59.8/>99	2.49×10^{-4}
2	PC-600	1878.4	0.97	2.06	73.4/>99	3.06×10^{-4}
3	PC-700	1612.9	0.79	1.96	99.9/>99	4.16×10^{-4}
4	PC-800	1821.5	0.93	2.04	96.2/>99	4.01×10^{-4}

Table S2. The calculated different types of oxygen containing species in PC-500, PC-600, PC-700 and PC-800 catalysts.

Entry	Catalyst	Total O [at. %]	Calculated [at. %]		
			C/P=O	C/P-O-C	C/P-OH
1	PC-500	7.54	2.22	3.08	2.24
2	PC-600	6.88	2.19	2.54	2.15
3	PC-700	5.85	1.73	2.61	1.51
4	PC-800	3.52	1.00	1.54	0.98

Table S3. The calculated contents of P-containing species of fresh and reused PC-700 catalysts based on the high-resolution P 2p spectra.

Entry	Catalyst	Total P [at. %]	Calculated [at. %]	
			P-C	P-O
1	Fresh PC-700	0.96	0.53	0.43
2	Reused PC-700	0.88	0.47	0.41

Table S4. The calculated contents of P-containing species of fresh and reused PC-700 catalysts based on the high-resolution O 1s spectra.

Entry	Catalyst	Total O [at. %]	Calculated [at. %]		
			C/P=O	C/P-O-C	C/P-OH
1	Fresh PC-700	5.85	1.73	2.61	1.51
2	Reused PC-700	6.39	2.10	2.72	1.57