

Supplementary Information

Catalytic Performance of Phosphorus Modified H-IM-5@meso-SiO₂ Composite in Alkylation of Toluene with Methanol

Dezhi Yi, Xuan Meng, Naiwang Liu, and Li Shi *

*The State Key Laboratory of Chemical Engineering, East China University of Science
and Technology, Shanghai 200237, China.*

** E-mail: yyshi@ecust.edu.cn. Tel.: 021-64252274.*

* To whom correspondence should be addressed. E-mail: yyshi@ecust.edu.cn Tel.: 021-64252274.

Table S1 The structural properties of H-IM-5 and H-ZSM-5 zeolites

Samples	SiO ₂ /Al ₂ O ₃	S _{BET} ^b	S _{micro} ^c	S _{meso} ^c	V _{total}	V _{micro} ^c	V _{meso} ^c
	ratio ^a	(m ² g ⁻¹)	(m ² g ⁻¹)	(m ² g ⁻¹)	(cm ³ g ⁻¹)	(cm ³ g ⁻¹)	(cm ³ g ⁻¹)
H-IM-5	47	382.477	286.107	96.370	0.355	0.142	0.213
H-ZSM-5	49	359.721	290.813	68.908	0.237	0.149	0.088

^a Calculated by ICP-OES; ^b Calculated by the BET method; ^c Calculated using the t-plot method.

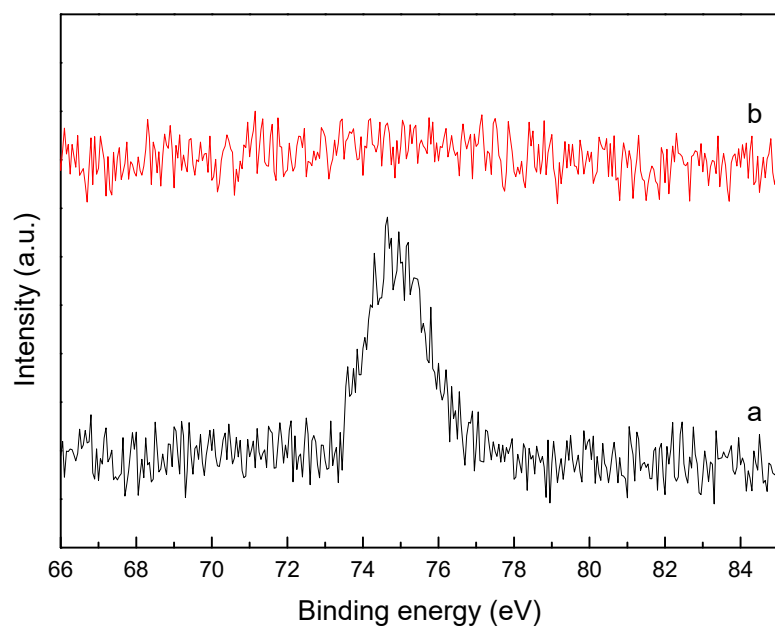


Fig. S1 XPS spectrums of Al 2p: a) H-IM-5, b) IM-2.4S.

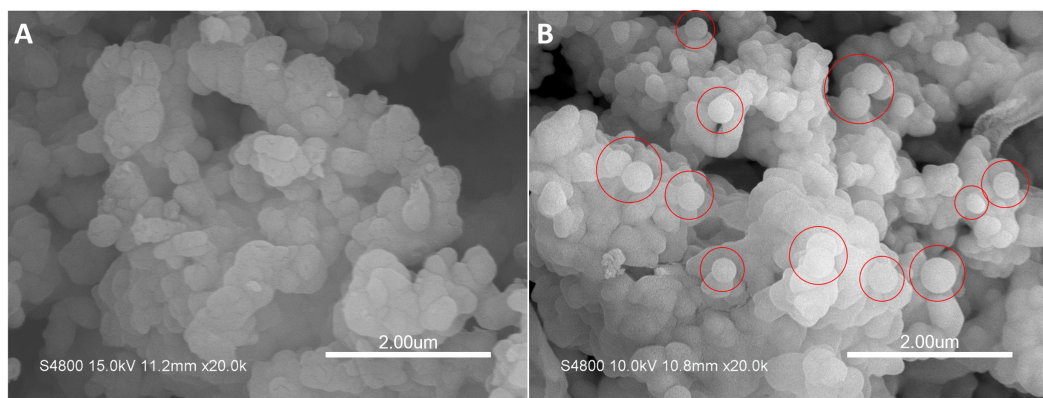


Fig. S2 SEM images of the synthesized H-IM-5@meso-SiO₂ samples: IM-2.4S samples obtained with (A) or without (B) PDDA pretreatment.

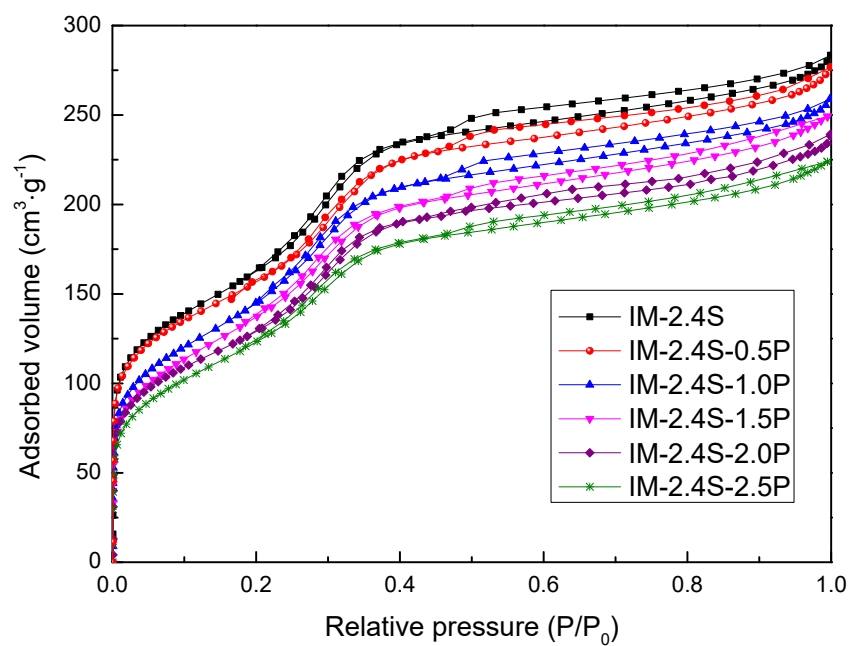


Fig. S3 N₂ adsorption-desorption isotherms of IM-2.4S and phosphorus modified samples.

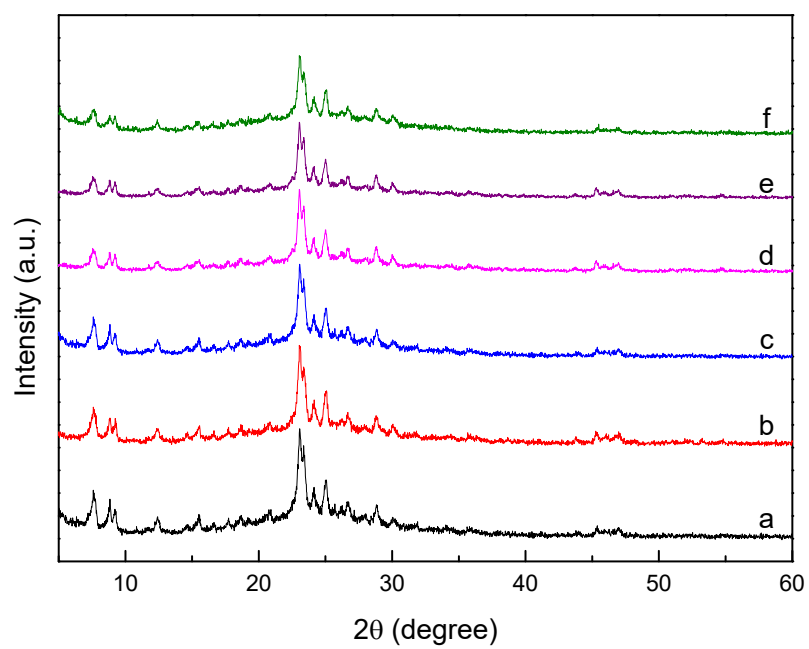


Fig. S4 X-ray diffraction patterns of IM-2.4S and phosphorus modified samples: (a) IM-2.4S, (b) IM-2.4S-0.5P, (c) IM-2.4S-1.0P, (d) IM-2.4S-1.5P, (e) IM-2.4S-2.0P, (f) IM-2.4S-2.5P.

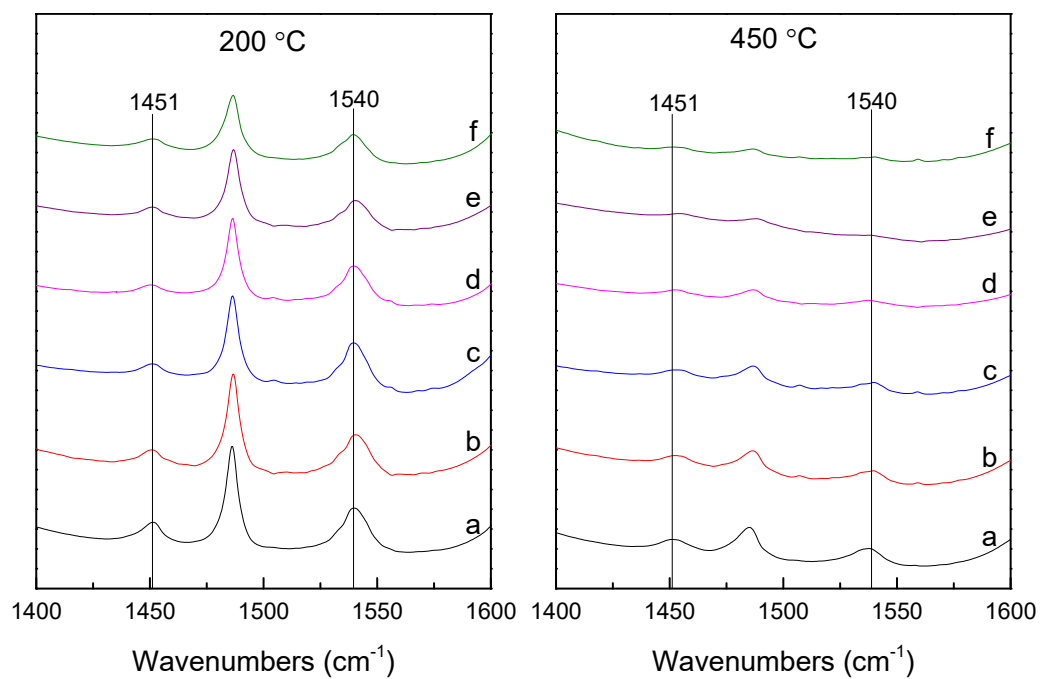


Fig. S5 Py-IR spectra of the samples at 200 and 450 °C: a) IM-2.4S, b) IM-2.4S-0.5P, c) IM-2.4S-1.0P, d) IM-2.4S-1.5P, e) IM-2.4S-2.0P, f) IM-2.4S-2.5P.

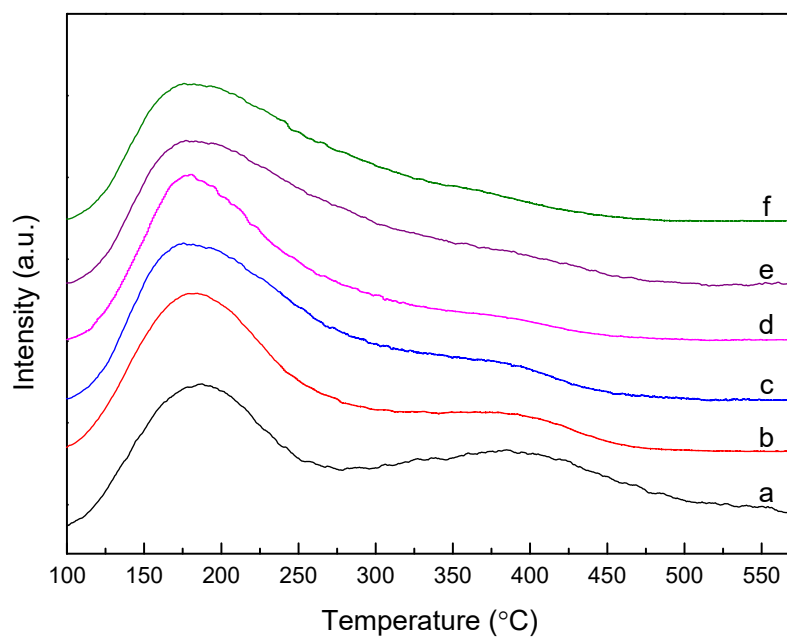


Fig. S6 NH₃-TPD profiles of the samples: a) IM-2.4S, b) IM-2.4S-0.5P, c) IM-2.4S-1.0P, d) IM-2.4S-1.5P, e) IM-2.4S-2.0P, f) IM-2.4S-2.5P.

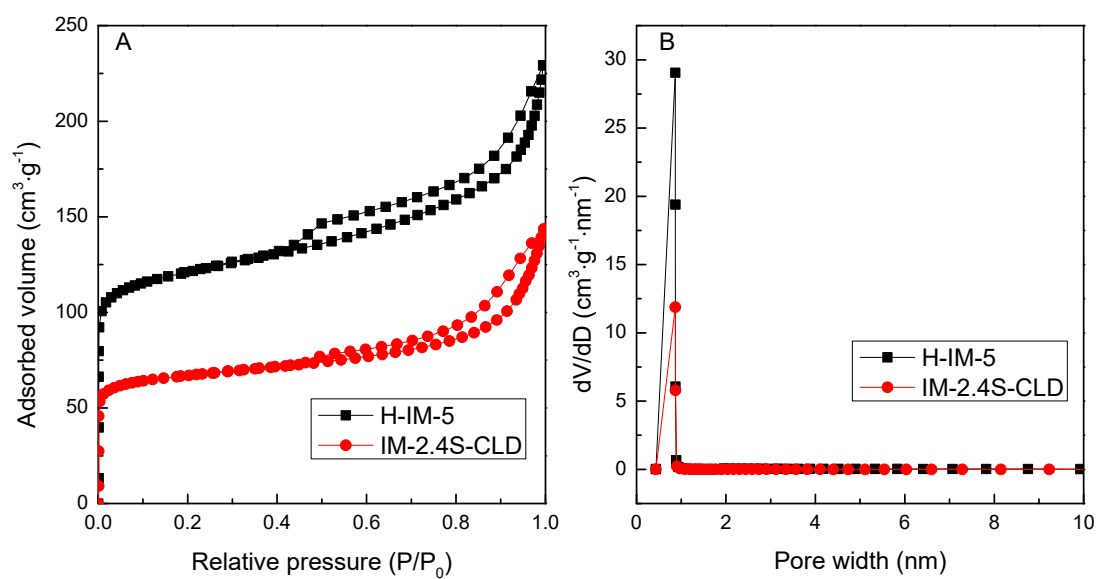


Fig. S7 (A) N₂ adsorption-desorption isotherms of H-IM-5 and IM-2.4S-CLD samples, (B) The corresponding pore size distributions based on the adsorption isotherms.

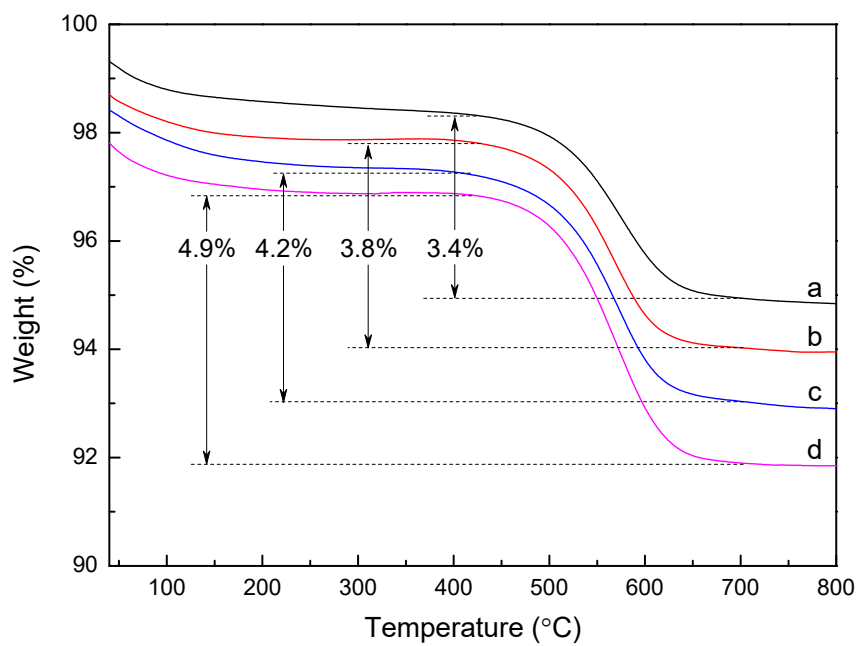


Fig. S8 TG curves of IM-2.4S-2.0P sample after 24 h alkylation reaction of toluene with methanol at different T/M feed molar ratios: a) T/M = 3.0, b) T/M = 2.0, c) T/M = 1.0, d) T/M = 0.5.

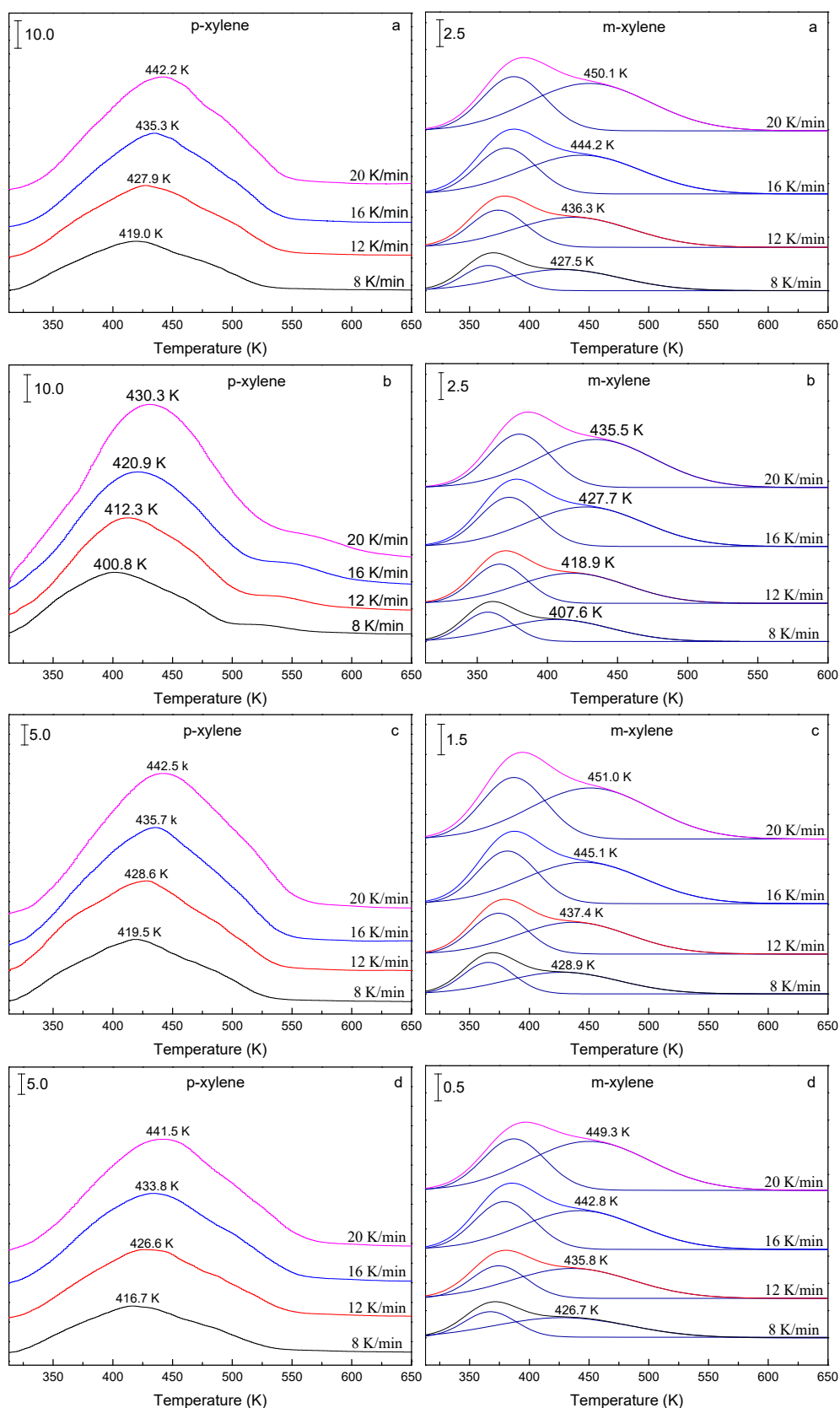


Fig. S9 TPD patterns for p-xylene and m-xylene on the samples at the different heating rates: a)

H-IM-5, b) H-ZSM-5, c) IM-2.4S and d) IM-2.4S-2.0P.