Supporting Information

P-toluenesulfonic acid functionalized imidazole ionic liquids encapsulated into bismuth SBA-16 as the high-efficiency catalyst for Friedel—Crafts acylation reaction

Guofang Gao, Qian Zhao, Chen Yang, Tingshun Jiang*

School of Chemistry and Chemical Engineering, Jiangsu University, Zhenjiang

212013, P. R. China

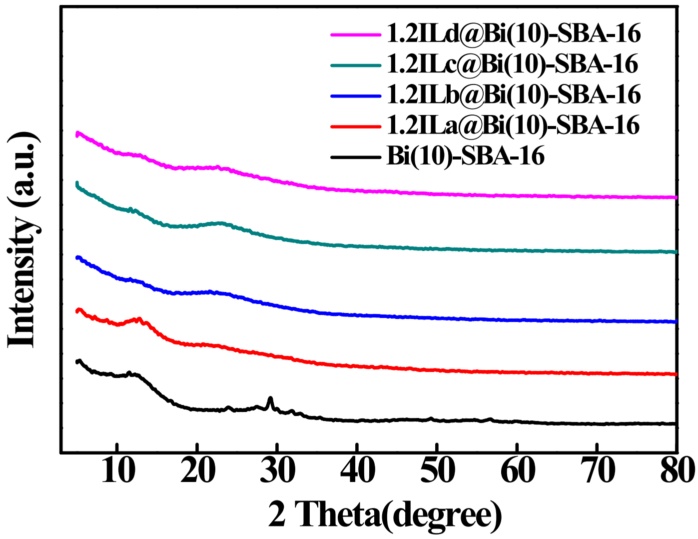


Fig. S1 Wide-angle XRD patterns of Bi(10)–SBA-16 catalysts and 1.2ILs@Bi(10)-SBA-16.

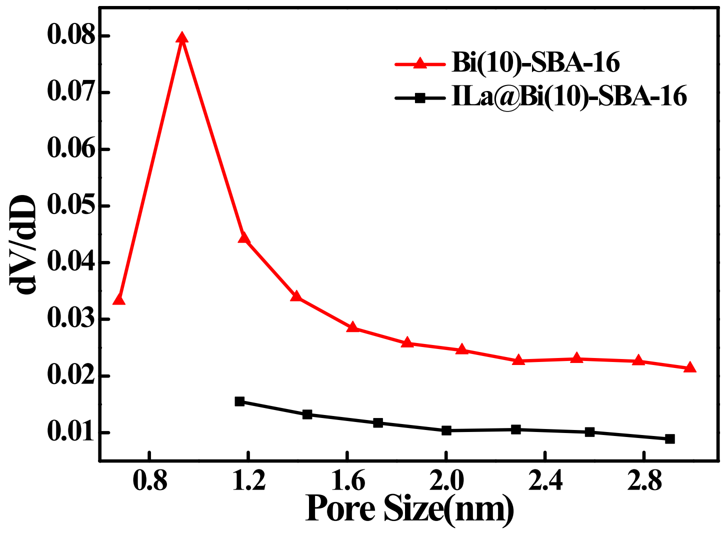
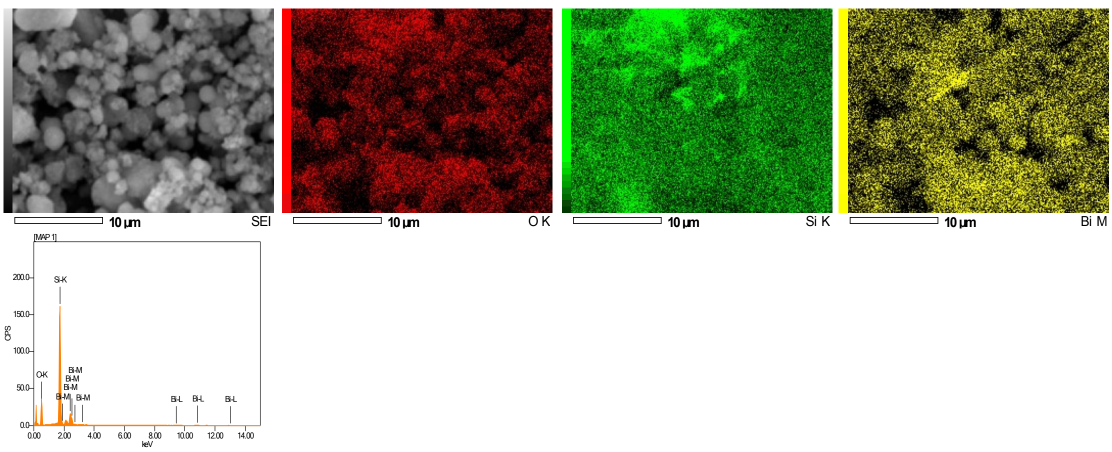
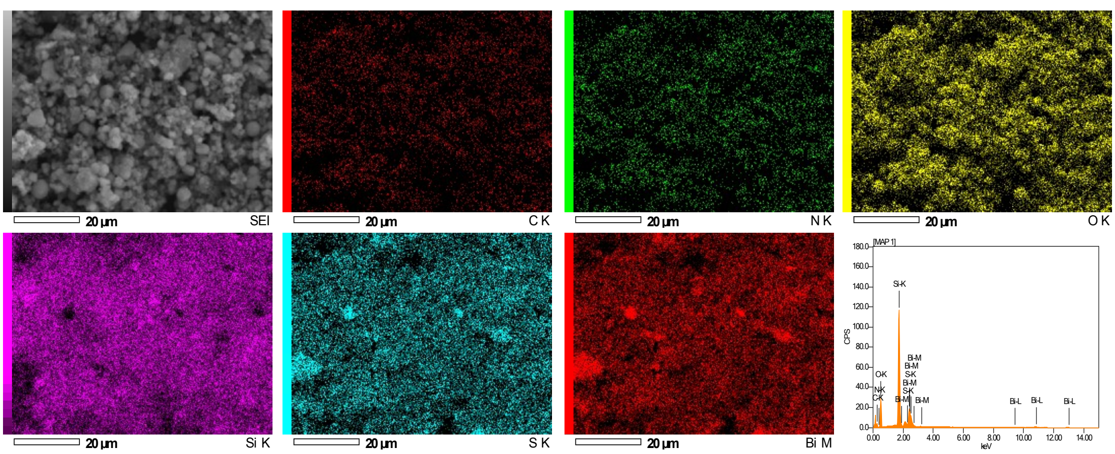


Fig. S2 N_2 adsorption-desorption isotherms and pore size distribution of microporous pore size distribution of Bi(10)-SBA-16 and ILa@Bi(10)-SBA-16.

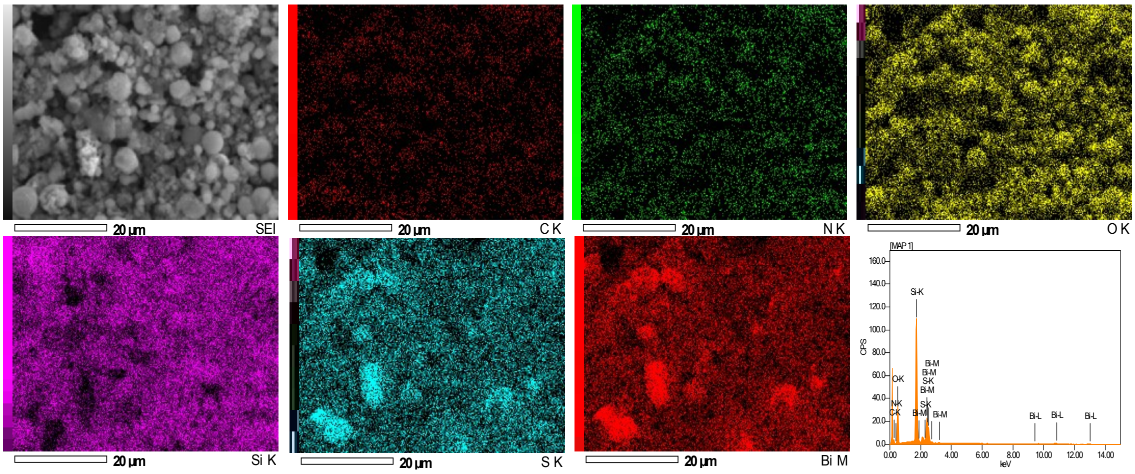
(A)



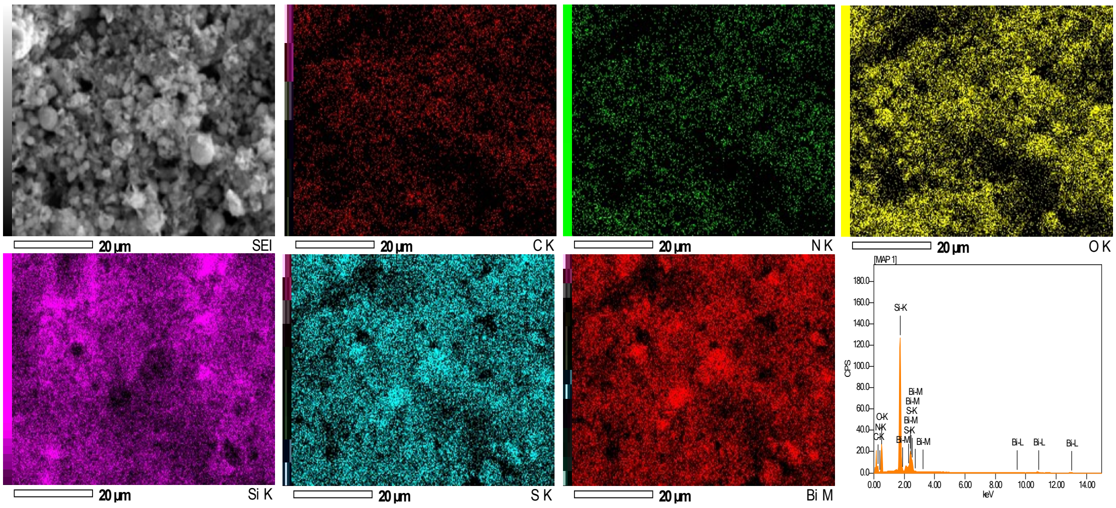
(B)



(C)


20 µm
SEI
C K
N K
O K
Si K
S K
Bi M
[MAP 1]
CPS
keV

(D)


20 µm
SEI
C K
N K
O K
Si K
S K
Bi M
[MAP 1]
CPS
keV

(E)

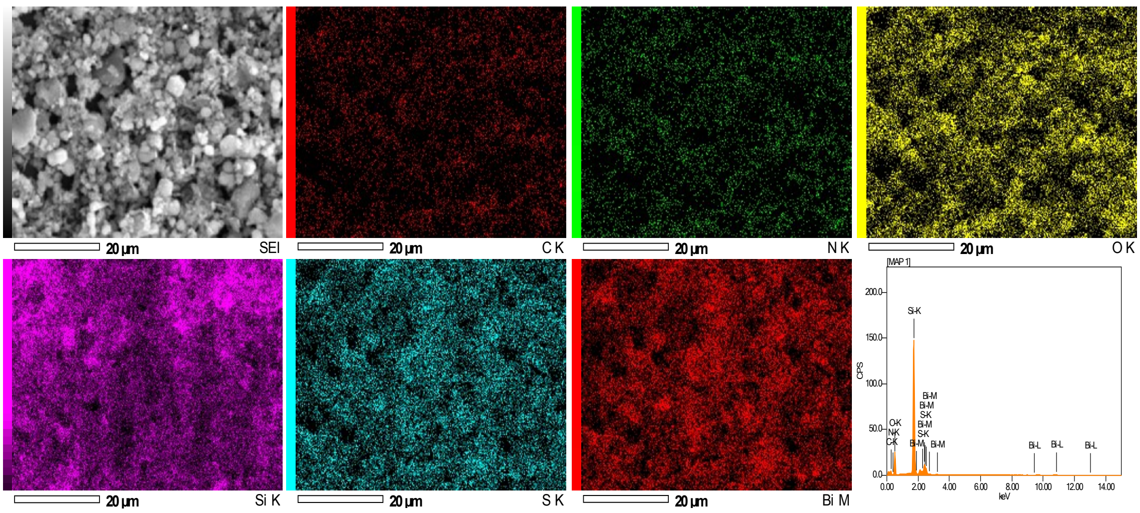
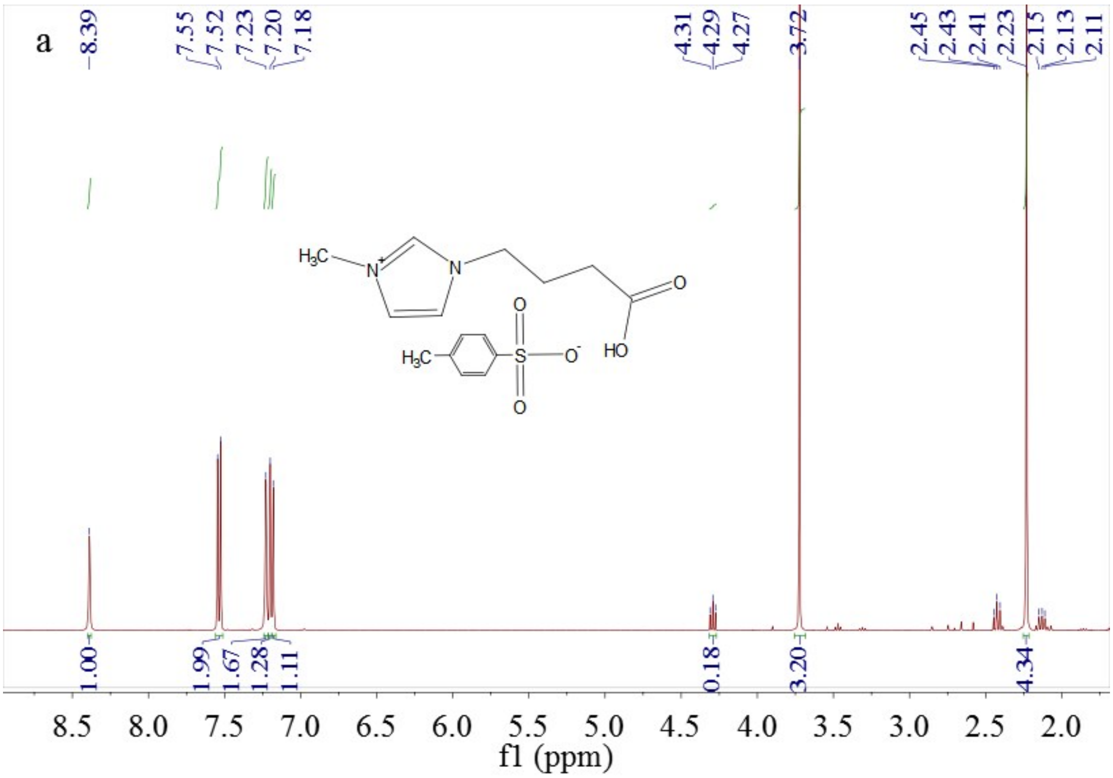
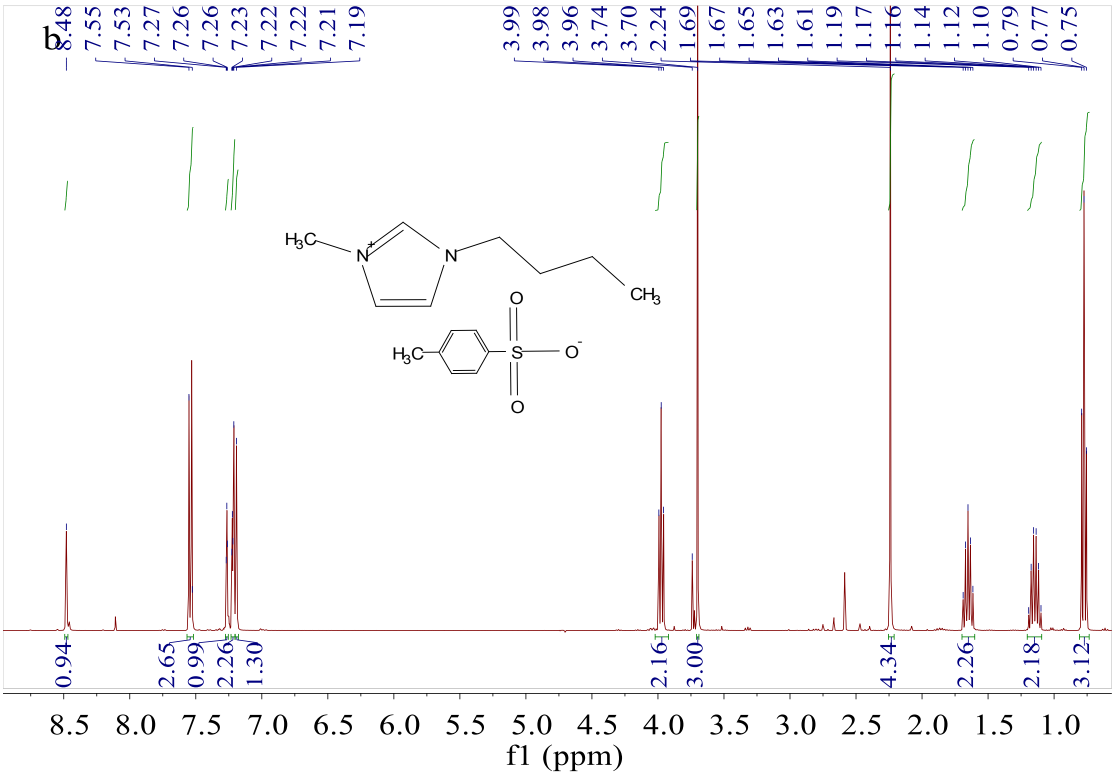

20 µm
SEI
C K
N K
O K
Si K
S K
Bi M
[MAP 1]
CPS
keV

Fig. S3 The EDS spectra of (A) Bi(10)-SBA-16, (B) 1.2ILa@ Bi(10)-SBA-16, (C) 1.2ILb@ Bi(10)-SBA-16, (D) 1.2ILc@ Bi(10)-SBA-16, (E) 1.2ILd@ Bi(10)-SBA-16.





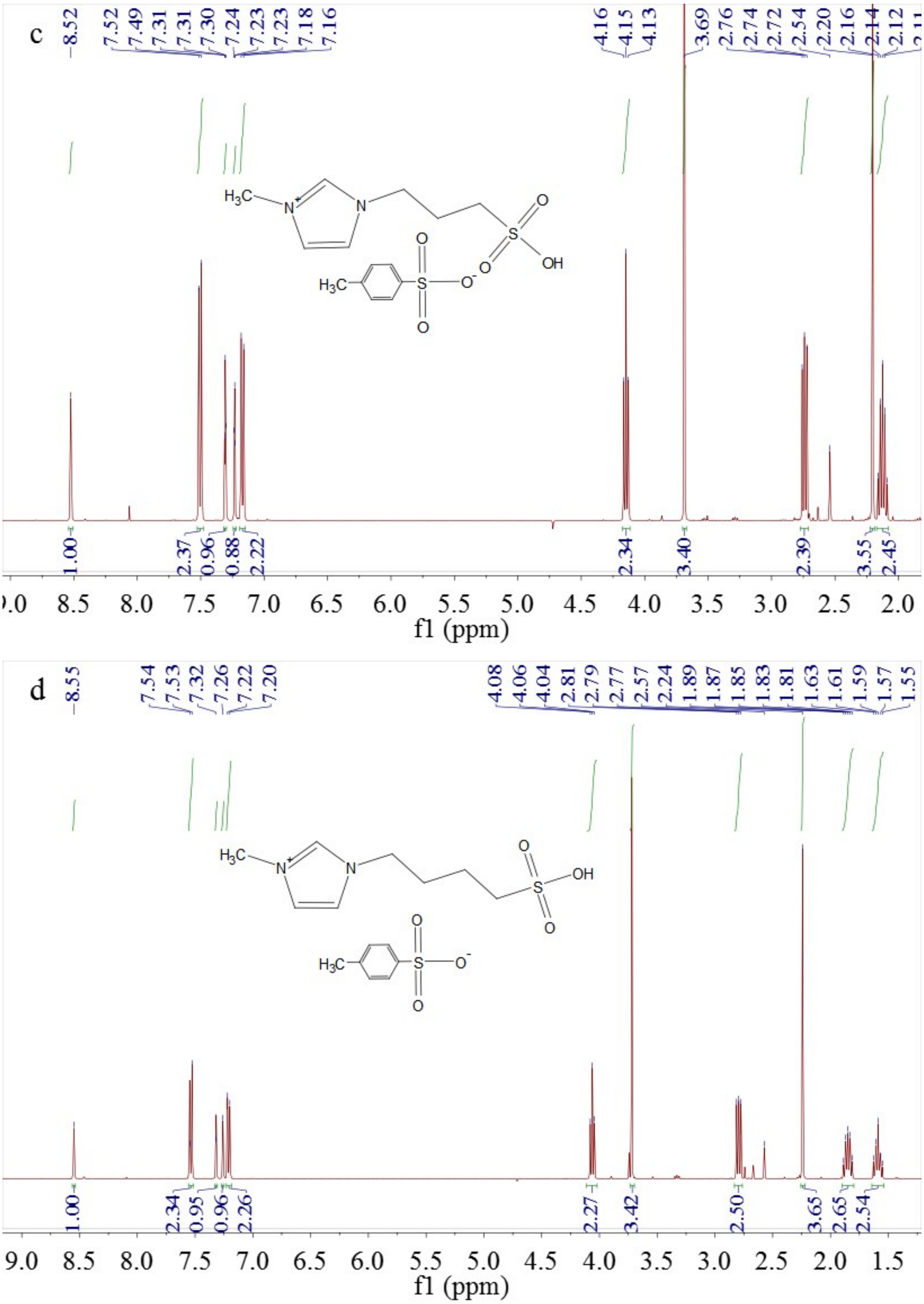
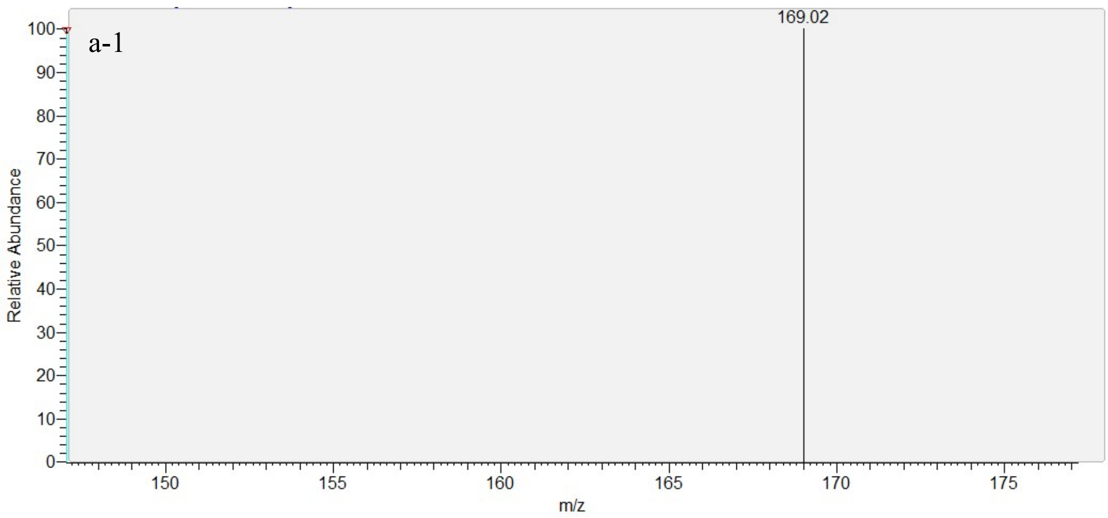
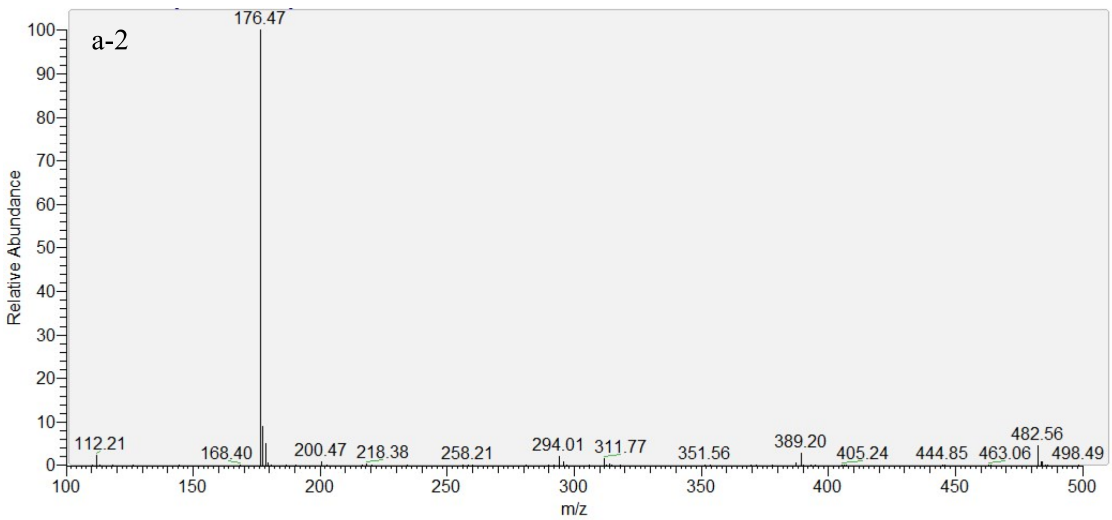
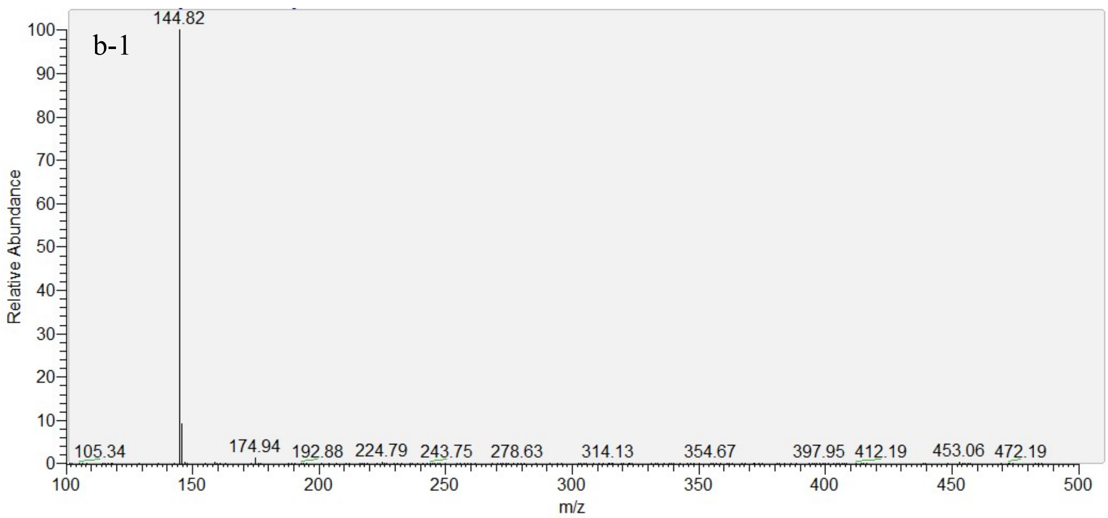
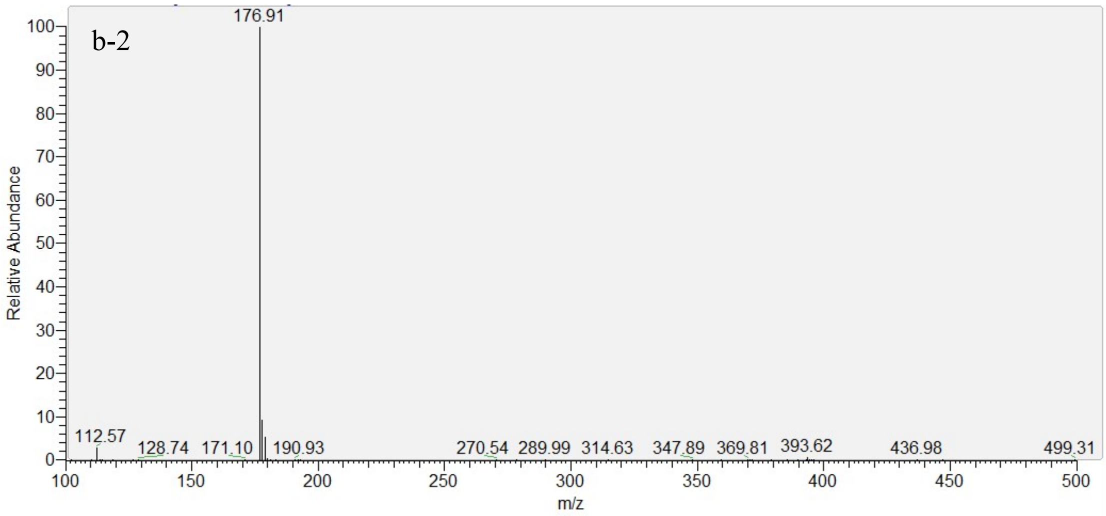


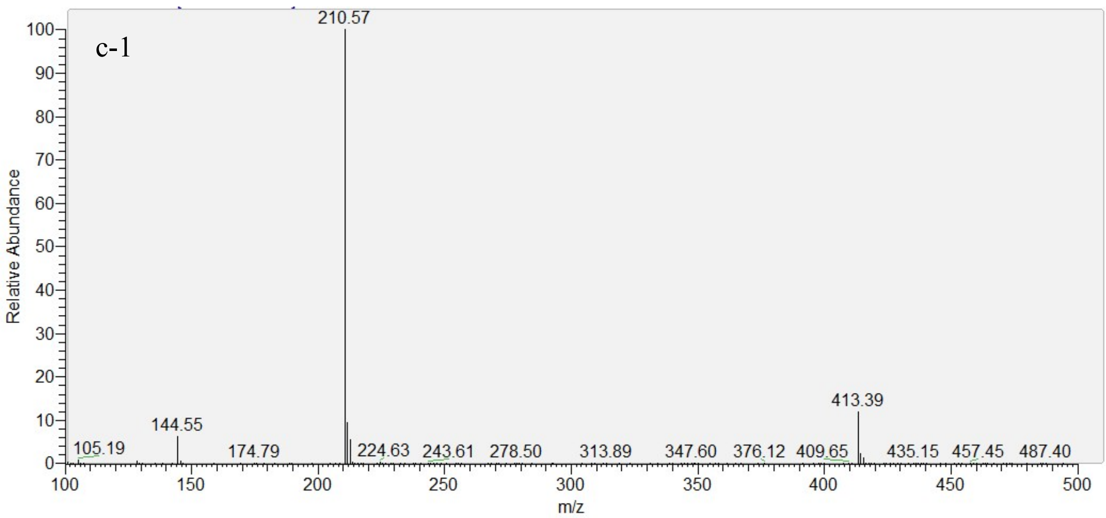
Fig. S4 ^1H NMR spectrum of (a) ILa、(b) ILb、(c) ILc、(d) ILd in D_2O.

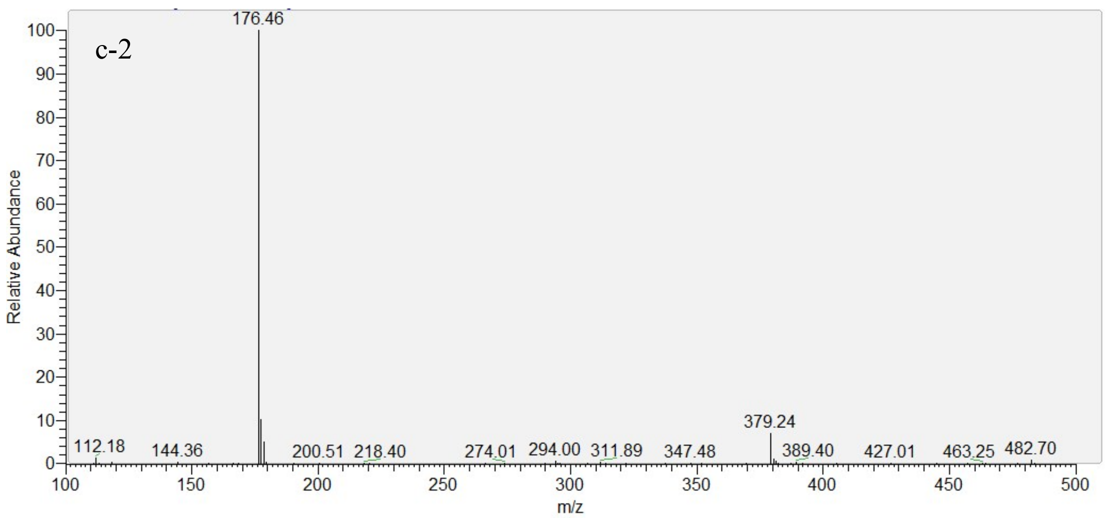

a-1
169.02
Relative Abundance
m/z

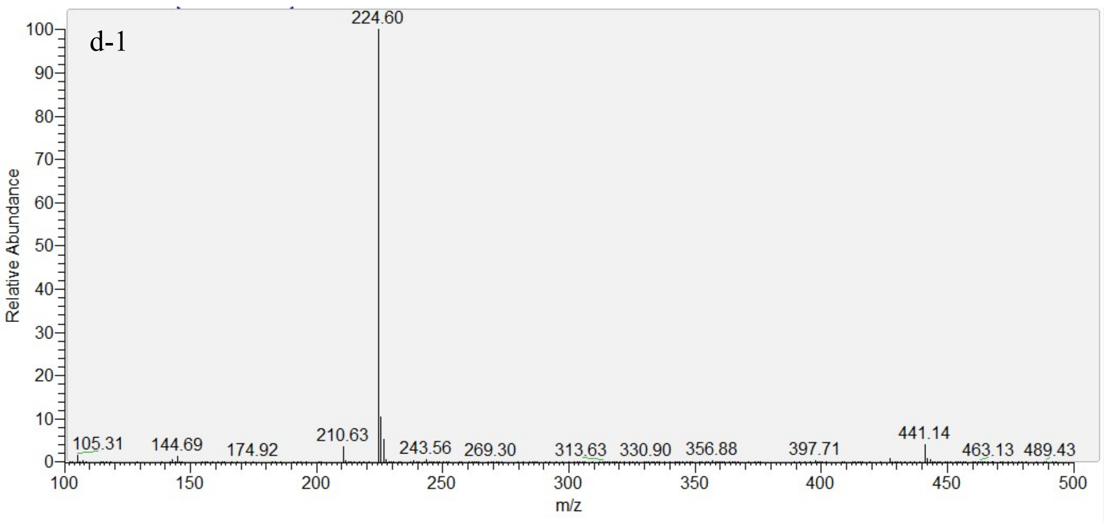

a-2
176.47
112.21
168.40
200.47
218.38
258.21
294.01
311.77
351.56
389.20
405.24
444.85
463.06
482.56
498.49
Relative Abundance
m/z


b-1
144.82
105.34
174.94
192.88
224.79
243.75
278.63
314.13
354.67
397.95
412.19
453.06
472.19
Relative Abundance
m/z


b-2
176.91
112.57
128.74
171.10
190.93
270.54
289.99
314.63
347.89
369.81
393.62
436.98
499.31
Relative Abundance
m/z


c-1
210.57
144.55
105.19
174.79
224.63
243.61
278.50
313.89
347.60
376.12
409.65
413.39
435.15
457.45
487.40
Relative Abundance
m/z


c-2
176.46
112.18
144.36
200.51
218.40
274.01
294.00
311.89
347.48
379.24
389.40
427.01
463.25
482.70
Relative Abundance
m/z



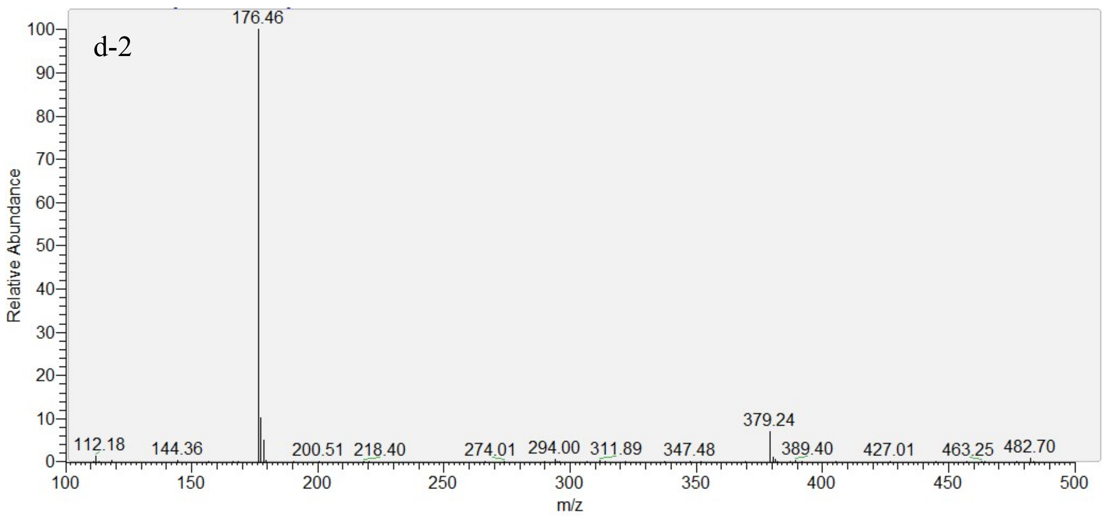


Fig. S5 GC-MS spectrum of (a) ILa , (b) ILb, (c) ILc, (d) ILd.

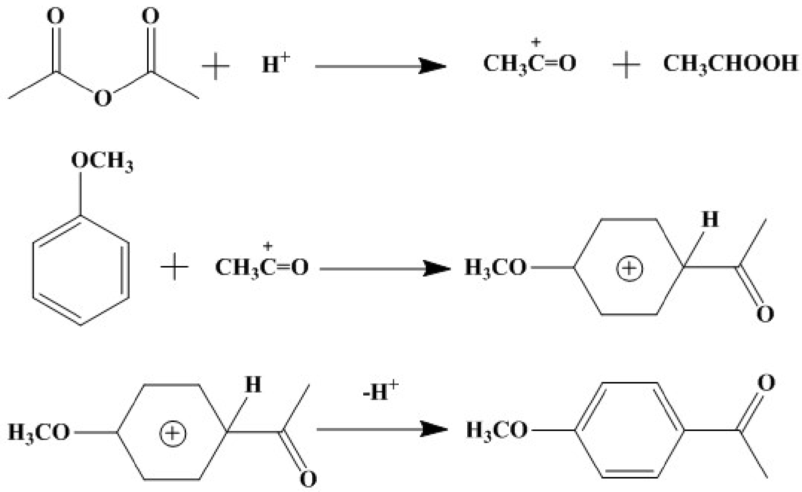


Fig. S6 Reaction mechanism diagram of anisole and acetic anhydride.

Table S1. Comparison of catalytic performance of various catalysts in the Friedel–Crafts acylation.

Catalyst	Conditions	Conversion%	References
HPW/MCM-41 (60% loading)	0.1 g of catalyst, The mole ratio of anisole to acetic anhydride was 4:1, at 120 ℃, for 1 h.	44.2	1
Nanocrystalline ZSM-5 of 90 nm particle sizes	0.2 g of catalyst, The mole ratio of anisole to acetic anhydride was 8:1, at 100 ℃, for 5 h.	66.2	2
HPA/SiO_2	170 mg of catalyst, The mole ratio of anisole to acetic anhydride was 10:1, at 90 ℃, for 250 min.	65	3
20%IL/MIL-101	0.5 g of catalyst, The mole ratio of anisole to acetic anhydride was 1:1, at 80 °C, for 1 h.	78.9	4

References:

[1] S. K. Abd El Rahman, H. M. Hassan, M.S. El-Shall, *Appl. Catal. A: General*, 2012, 411, 77-86.

[2] R. Selvin, H. L. Hsu and T. M. Her, *Catal. Commun.,* 2008, 10, 169-172.

[3] B. B. Baeza and J. Anderson, *J. Catal.,* 2004, 228, 225-233.

[4] M. A. Hassan, A. Mohamed, Betiha, S. K. Mohamed, E.A. El-Sharkawy and E. A. Ahmed, *J. Mol. Liq.*, 2017, 236, 385-394.