Electronic supplementary information

Title: Nitrogenous compounds produced by catalytic pyrolysis of cyanobacteria over metal loaded MCM-41 with vaporized methanol

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Table S1. BET specific surface area and pore structure of all catalyst samples

Samples	S_{BET}[a] (m^2/g)	V_{total} (mL/g)	Pore Diameter (nm)
MCM-41	1109.21	1.13	3.83
Al_2O_3/MCM-41	978.85	0.79	3.23
NiO/MCM-41	539.5	0.86	3.97
NiAl-LDO/MCM-41	796.76	0.72	3.62
NiAl-LDO	167.29	0.93	23.53

[a] From N_2 adsorption measurements(BET method).

Table S2. NH_3-TPD measurement of all catalyst samples

	Peak position/℃	Peak area/(a.u.)	Total acid amount /(mmol.g^{-1})
MCM-41	—	—	—
NiO/MCM-41	246	148.84	0.27
NiAl-LDO	230	258.22	0.52
Al_2O_3/MCM-41	243	400.41	0.80
NiAl-LDO/MCM-41	231	696.23	1.27

Table S3 Chemical components in bio-oils by GC/MS at different conditions

No.	Compounds	Molecular Formula	Relative content at different ocnditions (%)						
			None (N_2)	None	MCM-41	NiO/MCM-41	Al_2O_3/MC	NiAl-LDO/MCM-	NiAl-LD
	Aliphatic hydrocarbon								
1	Undecane	$C_{11}H_{24}$	0.58	0	0.87	0	0	1.01	0
2	Tridecane	$C_{13}H_{28}$	1.22	0	1.24	0	0	1.1	0
3	Undecane, 2,6-dimethyl-	$C_{13}H_{28}$	0	0	0	0	0	1.29	0
4	2-Tetradecene, (E)-	$C_{14}H_{28}$	0.92	0	0	0	0	0	0
5	1-Tetradecene	$C_{14}H_{28}$	0	0	1.16	0	0	0.98	0
6	Pentadecane	$C_{15}H_{32}$	1.4	1.05	1.38	0	0	0.78	0.74
7	2,6,10-Trimethyltridecane	$C_{16}H_{34}$	0	0	0	0	0	0	0.39
8	Hexadecane	$C_{16}H_{34}$	0.41	0	0	0	0	0	0
9	Heptadecane	$C_{17}H_{36}$	4.25	7.55	3.47	3.78	3.23	2.17	3.26
10	Cyclohexene, 4-(4-ethylcyclohexyl)-1-pentyl-	$C_{19}H_{34}$	0	1.21	0	0	0	0	0
11	Neophytadiene	$C_{20}H_{38}$	7.11	8.67	0	0	0	0	0
12	2-Hexadecene, 3,7,11,15-tetramethyl-,	$C_{20}H_{40}$	5.29	10.87	3.4	4.43	0	0	1.38
13	1-Hexacosene	$C_{26}H_{52}$	0	1.1	0	0	0	0	0
14	1-Hexadecyne	$C_{16}H_{30}$	1.07	0	0	0	0	0	0
	Total		**22.25**	**30.44**	**11.51**	**8.2**	**3.23**	**7.34**	**5.77**
	Aromatic compounds								
15	Benzene, 1,3-dimethyl-	C_8H_{10}	0	0	0	0	0	3.8	0
16	Ethylbenzene	C_8H_{10}	0.51	0	0	0	0	0	0
17	Styrene	C_8H_8	0.91	0	0.98	0	0	3.25	0
18	Benzene, propyl-	C_9H_{12}	0	0	0	0	0	1.48	0
19	Benzene, 1-ethenyl-3-methyl-	C_9H_{10}	0.49	0	0	0	0	0	0
20	Naphthalene, 1,2,3,4-tetrahydro-1,1,6-trimethyl-	$C_{13}H_{18}$	1.28	0	0	0	0	0	0
21	Benzene, 1-methoxy-4-methyl-	$C_8H_{10}O$	0	0	1.71	0	0	0	0
22	Phenol	C_6H_6O	10.14	0	3.75	0	0	0	4.09
23	Phenol, 2-methyl-	C_7H_8O	0.96	0	0	0	0	0	0.47
24	p-Cresol	C_7H_8O	4.64	0	7.23	0	0	3.35	3.25
25	Phenol, 2,4-dimethyl-	$C_8H_{10}O$	0.88	0	0	0	0	0	0
26	Phenol, 4-ethyl-	$C_8H_{10}O$	0.91	0	0	0	0	0	0
	Total		**20.72**	**0**	**13.67**	**0**	**0**	**11.88**	**7.81**
	Nitrogenous compounds								
27	1H-Pyrrole, 2,3-dimethyl-	C_6H_9N	1.66	0	0	0	0	0	0
28	Pyridine, 2,4-dimethyl-	C_7H_9N	0	0	0	0	0	0	0.68
20	1H-Pyrrole, 2-methyl-	C_5H_7N	0.69	0	0.88	0	0	0	0
30	1H-Pyrrole, 3-methyl-	C_5H_7N	0	0	0	0	0	0.9	0
31	1H-Pyrrole, 2-ethyl-4-methyl-	$C_7H_{11}N$	0	0	1.28	0	0	0	0

32	1H-Pyrrole, 2,3,5-trimethyl-	$C_7H_{11}N$	0.83	0	0	0	0	0	0
33	Indole	C_8H_7N	11.83	0	7.78	0	2.29	5.84	5.73
34	Indole, 3-methyl-	C_9H_9N	2.21	0	0	0	0	0	1.53
35	1H-Indole, 5-methyl-	C_9H_9N	0	0	1.38	0	0	0	0
36	1H-Indole, 4-methyl-	C_9H_9N	0	0	0	0	0	1.54	0
37	1H-Indole-3-propanoic acid	$C_{11}H_{11}NO_2$	0	0	0	0	0	0	1
38	Indolizine	C_8H_7N	0	1.41	0	0	0	0	0
39	Benzyl nitrile	C_8H_7N	0	0	0	0	0	0.95	1.36
40	Benzene, 1-isocyano-2-methyl-	C_8H_7N	2.66	0	1.48	0	0	0	0
41	Benzenepropanenitrile	C_9H_9N	4.45	0	0	0	0	3.87	3.54
42	Pentadecanenitrile	$C_{15}H_{29}N$	11.8	18.45	50.95	69.48	78.92	56.98	59.9
43	Oleanitrile	$C_{18}H_{33}N$	0.43	0	5.73	4.93	6.39	4.92	4.98
44	Heptadecanenitrile	$C_{17}H_{33}N$	0	0	0	0	0	1.76	1.88
45	Octadecanenitrile	$C_{18}H_{35}N$	0	0	0	0	2.28	0	0
46	9-Octadecenamide, (Z)-	$C_{18}H_{35}NO$	1.11	0	0	0	0	0	0
47	Hexadecanamide	$C_{16}H_{33}NO$	10.79	26.93	1.01	7.99	2.72	1.86	2.11
48	N-Methyldodecanamide	$C_{13}H_{27}NO$	0	0	0	2.41	0	0	0
	Total		**48.46**	**46.79**	**72.23**	**84.82**	**92.59**	**78.62**	**82.8**
	Oxygenic compounds								
49	4-Methyl-dodec-3-en-1-ol	$C_{13}H_{26}O$	0.2	0	0	0	0	0	0
50	Phytol	$C_{20}H_{40}O$	1.4	0	0	0	0	0	0
51	4-Hydroxy-2,2,7,7-tetramethyl-octahydro-2H-dib	$C_{16}H_{24}O_4$	0.88	0	0	0	0	0	0
52	(R)-(-)-14-Methyl-8-hexadecyn-1-ol	$C_{17}H_{32}O$	0	2.7	0	0	0	0	0
53	2-Hydroxy-5-methoxybenzaldehyde,	$C_{12}H_{16}O_3$	0.83	0	0	0	0	0	0
54	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	2.93	10.72	0	0	0	0.99	0
55	Linoelaidic acid	$C_{18}H_{32}O_2$	0	0	0	0	0	0	3.05
56	9,12-Octadecadienoic acid (Z,Z)-	$C_{18}H_{32}O_2$	0	0	2.59	0	2.98	0	0
57	2-Dodecen-1-yl(-)succinic anhydride	$C_{16}H_{26}O_3$	0	1.98	0	0	0	0	0
58	2(4H)-Benzofuranone,	$C_{11}H_{16}O_2$	0.69	0	0	0	0	0	0
59	Hexadecanoic acid, methyl ester	$C_{17}H_{34}O_2$	1.65	7.37	0	6.98	1.2	1.16	0.56
	Total		**8.57**	**22.77**	**2.59**	**6.98**	**4.17**	**2.15**	**3.61**

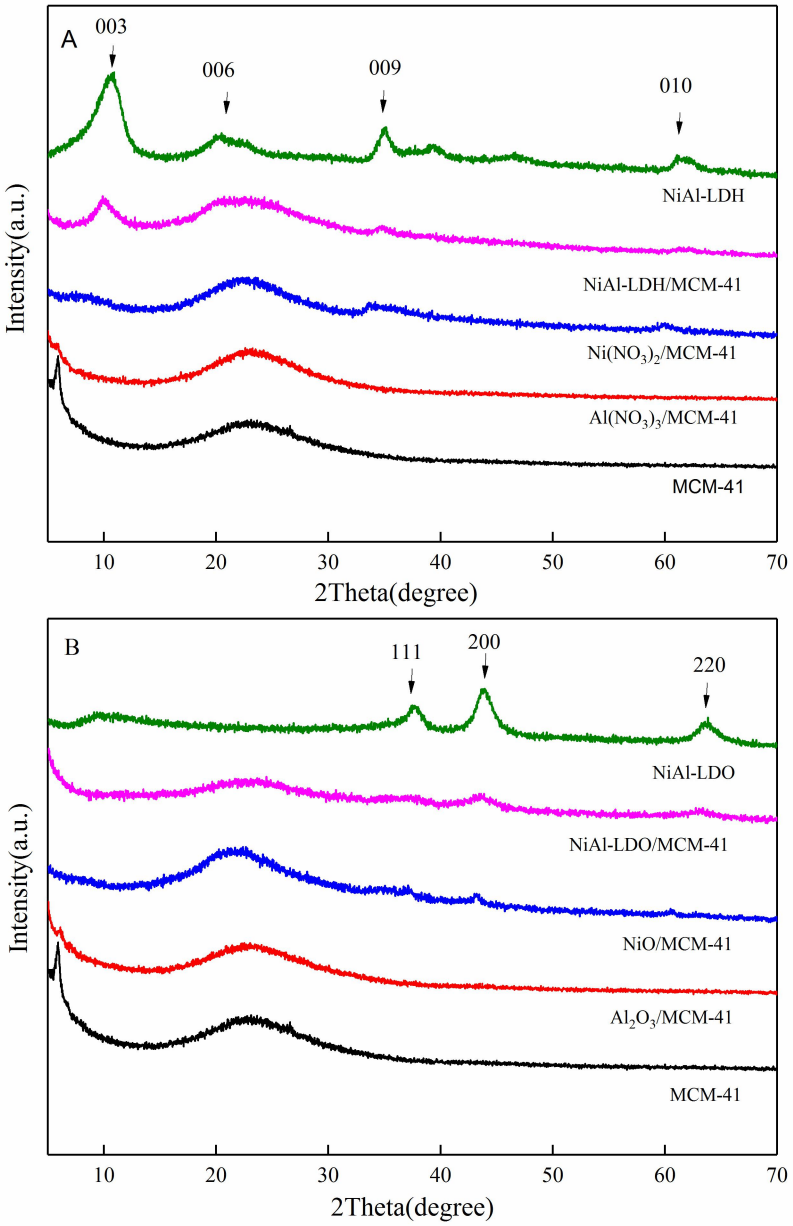

Fig. S1. XRD patterns of different catalysts

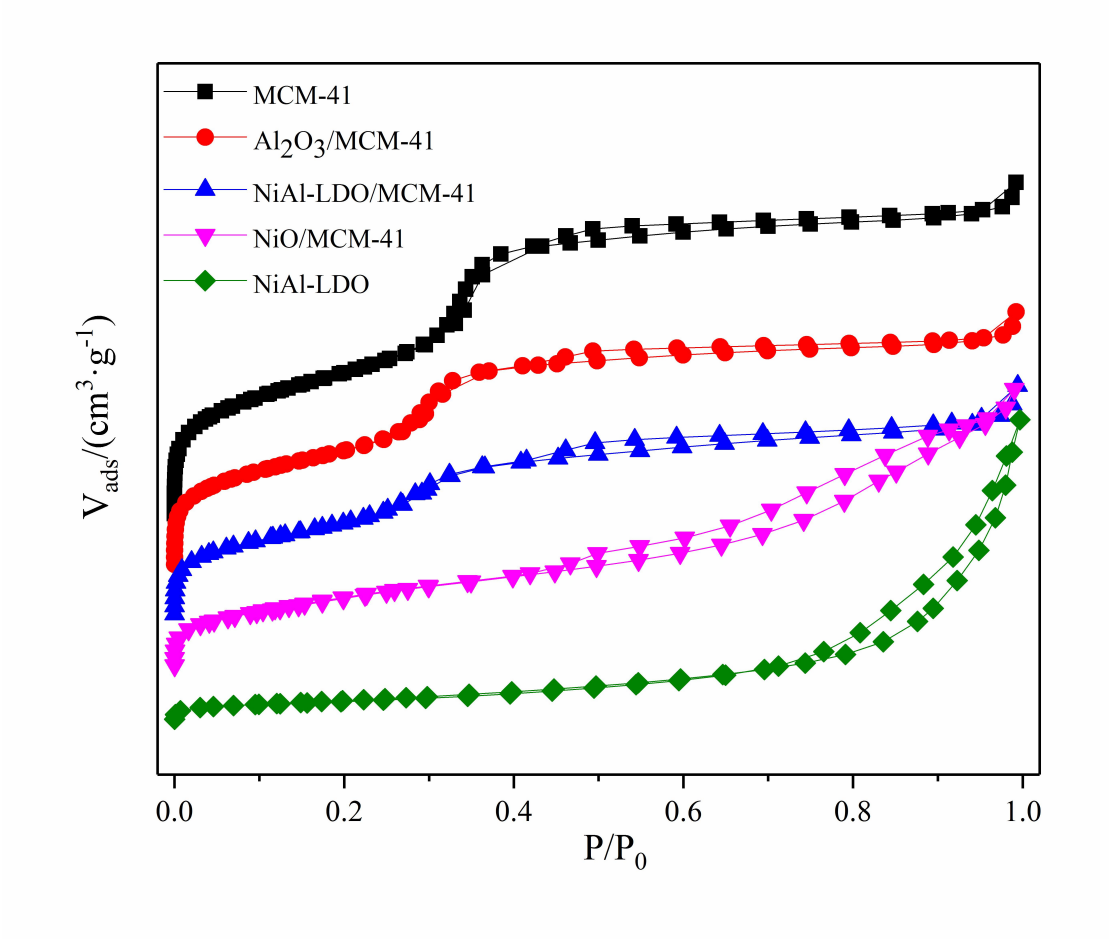

Fig. S2. Nitrogen adsorption-desorption isotherms of different catalysts

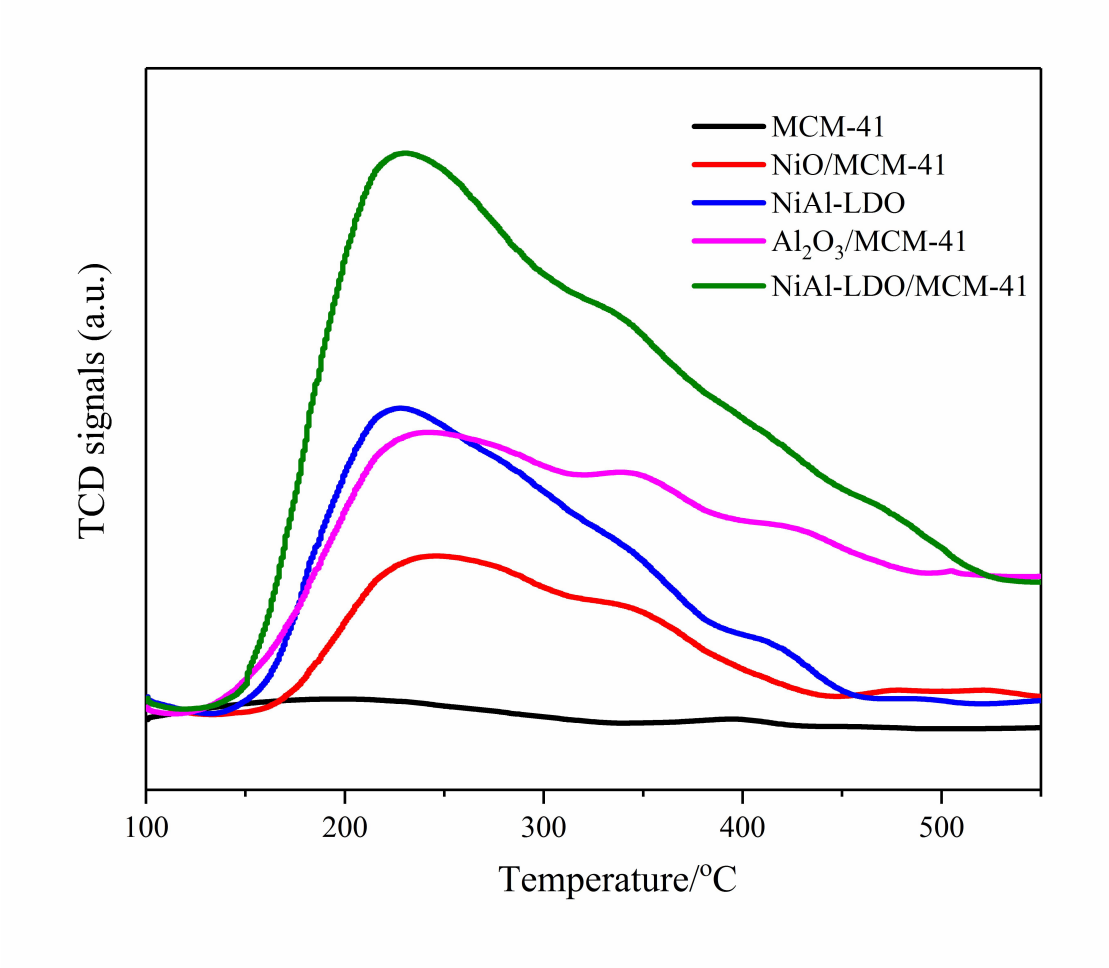

Fig. S3. NH_3-TPD curve of different catalysts