

Supporting Information

Investigation of Ni-modified MCM-41 catalyst for the reduction of oxygenates and carbon deposits during the co-pyrolysis of cellulose and polypropylene

Yu Shi¹, Chang Liu¹, Jiankun Zhuo^{1,2,*}, Qiang Yao^{2,3}

¹Key Laboratory for Thermal Science and Power Engineering of Ministry of Education, Department of energy and power Engineering, Tsinghua University, Beijing 100084, China

²Beijing Engineering Research Center for Ecological Restoration and Carbon Fixation of Saline–alkaline and Desert Land, Tsinghua University, Beijing 100084, China

³School of Electric Engineering , Xinjiang University, Urumqi 830047, China

Figures:

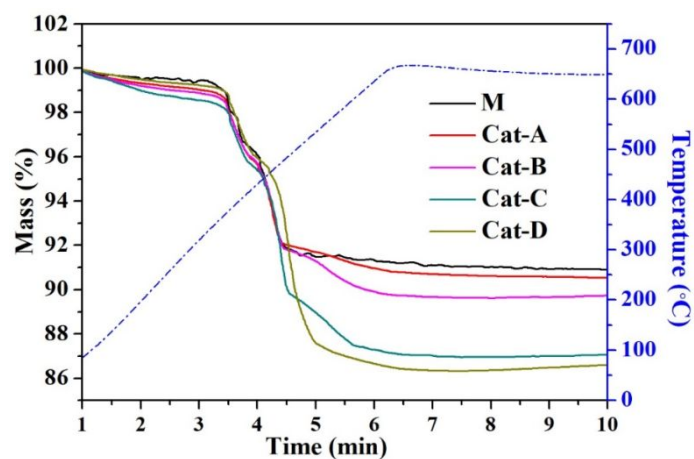


Figure S1. TGA profiles for five catalysts (Under N_2 atmosphere, the temperature was raised to $650\text{ }^\circ\text{C}$ at a temperature ramp rate of $100\text{ }^\circ\text{C}\cdot\text{min}^{-1}$, and maintained for 5 mins)

All fresh catalysts were used to pyrolyze cellulose and PP at $650\text{ }^\circ\text{C}$ for 5 minutes in an N_2 atmosphere with a catalyst to reactant mass ratio of 10 to 1, the TGA curves are all shown in Fig. S1. At the end of the reaction, the quality of each sample all reached stable level.

Tables:

Table S1

Main identified products from catalytic co-pyrolysis of cellulose and PP with catalyst M

RT (min)	Peak Name	Chem. Formula	Relative Area (%)
2.17	2-Butene, 2-methyl-	C ₅ H ₁₀	10.41
2.50	2-Pentene, 3-methyl-, (Z)-	C ₆ H ₁₂	6.04
2.78	2-Pentene, 2,4-dimethyl-	C ₇ H ₁₄	2.14
2.86	Cyclopentanone, 2-methyl-	C ₆ H ₁₀ O	0.53
3.13	Cyclopentane, 1,3-dimethyl-, cis-	C ₇ H ₁₄	0.53
3.28	(R)-(+)-3-Methylcyclopentanone	C ₇ H ₁₄	5.57
3.90	2,4-Pentadien-1-ol, 3-ethyl-, (2Z)-	C ₇ H ₁₂ O	0.79
4.13	3-Octene, (Z)-	C ₈ H ₁₆	0.89
4.38	Toluene	C ₇ H ₈	2.86
4.79	1,4-Cyclohexanedione	C ₆ H ₈ O ₂	0.24
5.06	Hexane, 3-methyl-4-methylene-	C ₈ H ₁₆	3.15
5.38	1-Octanol	C ₈ H ₁₈ O	1.56
5.87	2,2-Dimethyl-3-heptene trans	C ₉ H ₁₈	0.33
6.06	Furfural	C ₅ H ₄ O ₂	12.53
6.33	2,4-Dimethyl-1-heptene	C ₉ H ₁₈	1.02
6.43	2,3-Dimethyl-3-heptene	C ₉ H ₁₈	0.89
6.65	4-Nonene	C ₉ H ₁₈	1.17
6.83	trans--4-Nonene	C ₉ H ₁₈	0.32
6.99	Ethylbenzene	C ₈ H ₁₀	0.53
7.14	Cyclohexanone, 3,5-dimethyl-	C ₈ H ₁₄ O	0.41
7.36	o-Xylene	C ₈ H ₁₀	3.44
7.71	Cyclohexane, (2-methylpropyl)-	C ₁₀ H ₂₀	3.05
8.15	Ethylbenzene	C ₈ H ₁₀	1.20
9.44	4-Isopropylcyclohexanone	C ₉ H ₁₆ O	0.66
10.52	4-Isopropylcyclohexanone	C ₉ H ₁₆ O	0.68
10.79	1-Decanol	C ₁₀ H ₂₂ O	0.66
11.00	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	2.98
11.39	Benzene, 1,3,5-trimethyl-	C ₉ H ₁₂	1.00
11.77	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	0.32
11.93	Phenol	C ₆ H ₆ O	0.40
12.11	4-Undecene, (Z)-	C ₁₁ H ₂₂	0.59
12.51	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	3.55
12.75	4-Isopropylcyclohexanone	C ₉ H ₁₆ O	0.73

13.74	Benzene, 1,2,4-trimethyl-	C ₉ H ₁₂	0.95
14.36	Indane	C ₉ H ₁₀	0.76
14.78	Indene	C ₉ H ₈	0.62
15.02	1-Dodecene	C ₁₂ H ₂₄	0.42
15.17	5-Undecene, (Z)-	C ₁₁ H ₂₂	0.50
15.73	2-Pentene, 3,4-dimethyl-, (Z)-	C ₇ H ₁₄	0.64
16.36	Benzene, 4-ethyl-1,2-dimethyl-	C ₁₀ H ₁₄	0.20
17.13	1,2-Benzenediol, 3-methyl-	C ₇ H ₈ O ₂	0.20
17.32	2H-Inden-2-one, 1,3-dihydro-	C ₉ H ₈ O	0.40
18.28	Benzene, 1,2,4,5-tetramethyl-	C ₁₀ H ₁₄	0.58
18.44	Benzene, 1,2,4,5-tetramethyl-	C ₁₀ H ₁₄	0.71
19.88	Benzene, 1,2,4,5-tetramethyl-	C ₁₀ H ₁₄	0.60
21.44	Naphthalene	C ₁₀ H ₈	0.27
22.91	Phenol, 2-methyl-6-(2-propenyl)-	C ₁₀ H ₁₂ O	0.17
25.80	Phenol, 2-methyl-6-(2-propenyl)-	C ₁₂ H ₁₂ O	0.99
26.49	Naphthalene, 2-methyl-	C ₁₁ H ₁₀	0.53
26.93	1-Tetradecene	C ₁₄ H ₂₈	0.50
31.79	Naphthalene, 1,8-dimethyl-	C ₁₂ H ₁₂	0.38
35.96	1-Octadecanol	C ₁₈ H ₃₈ O	0.46
36.33	Naphthalene, 1,6,7-trimethyl-	C ₁₃ H ₁₄	0.42
36.88	Naphthalene, 1,6,7-trimethyl-	C ₁₃ H ₁₄	0.36
37.62	1-Nonadecene	C ₁₉ H ₃₈	0.49
38.30	Fluorene	C ₁₃ H ₁₀	0.32
42.72	1-Nonadecene	C ₁₉ H ₃₈	0.49

Table S2

Main identified products from catalytic co-pyrolysis of cellulose and PP with Cat-A

RT (min)	Peak Name	Chem. Formula	Relative Area (%)
1.99	2-Butene	C ₄ H ₈	1.70
2.13	2-Pentene, (E)-	C ₅ H ₁₀	11.62
2.45	2-Pentene, 3-methyl-	C ₆ H ₁₂	11.17
2.73	2,4-Hexadien-1-ol	C ₆ H ₁₀ O	5.54
2.87	Benzene	C ₆ H ₆	4.25
3.08	Cyclopentane, 1,3-dimethyl-	C ₇ H ₁₄	1.34
3.25	3-Furanmethanol	C ₅ H ₆ O ₂	3.87
4.09	Bicyclo[3.3.1]non-3-en-2-ol, exo-	C ₉ H ₁₄ O	2.12
4.20	3-Octene, (Z)-	C ₈ H ₁₆	0.46
4.35	Cyclobutene, 2-propenylidene-	C ₇ H ₈	4.86
4.58	(5-Methylcyclopent-1-enyl)methanol	C ₇ H ₁₂ O	0.22
4.72	3-Octene, (Z)-	C ₈ H ₁₆	0.26
4.87	4-Octene, (E)-	C ₈ H ₁₆	0.63

5.06	Cyclopentanone, 2-(1-methylpropyl)-	C ₉ H ₁₆ O	2.89
5.33	3-Octene, (Z)-	C ₈ H ₁₆	0.59
5.47	Furfural	C ₅ H ₄ O ₂	0.22
6.02	Furfural	C ₅ H ₄ O ₂	7.89
6.26	2,4-Dimethyl-1-heptene	C ₉ H ₁₈	1.11
6.37	trans--4-Nonene	C ₉ H ₁₈	1.39
6.60	trans--4-Nonene	C ₉ H ₁₈	1.05
6.77	Cyclohexane, propyl-	C ₉ H ₁₈	0.46
6.96	Ethylbenzene	C ₈ H ₁₀	1.10
7.09	cis,cis-4,6-Octadienol	C ₈ H ₁₄ O	0.75
7.30	Benzene, 1,3-dimethyl-	C ₈ H ₁₀	3.46
7.66	3-Octene, 2,2-dimethyl-	C ₁₀ H ₂₀	1.31
7.88	4,4-Dimethyl-cyclohex-2-en-1-ol	C ₈ H ₁₄ O	0.36
8.10	o-Xylene	C ₈ H ₁₀	1.68
8.27	2,3-Dimethyl-3-heptene	C ₉ H ₁₈	0.24
8.38	3-Heptene, 2,6-dimethyl-	C ₉ H ₁₈	0.17
8.53	Furan, 2,5-dimethyl-	C ₆ H ₈ O	0.20
8.75	5-Octen-2-yn-4-ol	C ₈ H ₁₂ O	0.19
9.38	2-Butenal, 2-ethyl-	C ₆ H ₁₀ O	0.49
9.93	Cyclopentanone, 2-methyl-3-(1-methylethyl)-	C ₉ H ₁₆ O	0.30
10.48	Cyclopentanone, 2-methyl-3-(1-methylethyl)-	C ₉ H ₁₆ O	0.21
10.73	3-Decyn-2-ol	C ₁₀ H ₁₈ O	0.26
10.97	2,5,8- Trimethyl-1-nonen-3-yn-5-ol	C ₁₂ H ₂₀ O	2.50
11.10	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	0.36
11.34	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	0.64
11.72	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	0.27
11.89	Phenol	C ₆ H ₆ O	0.46
12.45	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	2.28
12.70	7-Octenal, 3,7-dimethyl-	C ₁₀ H ₁₈ O	0.28
13.12	2,4-Pentadien-1-ol, 3-pentyl-, (2Z)-	C ₁₀ H ₁₈ O	0.20
13.68	Benzene, 1,2,4-trimethyl-	C ₉ H ₁₂	0.71
13.92	trans-p-mentha-1(7),8-dien-2-ol	C ₁₀ H ₁₆ O	0.17
14.73	Indene	C ₉ H ₈	0.51
14.96	Benzene, 1,4-diethyl-	C ₁₀ H ₁₄	0.34
15.12	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	0.41
15.28	Phenol, 3-methyl-	C ₇ H ₈ O	0.35
15.36	Benzyl Alcohol	C ₇ H ₈ O	0.26
15.44	Benzene, 1-ethyl-2,4-dimethyl-	C ₁₀ H ₁₄	0.56
15.66	Cyclohexane, pentyl-	C ₁₁ H ₂₂	0.27
15.79	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	0.19
16.31	Benzene, 2-ethyl-1,4-dimethyl-	C ₁₀ H ₁₄	0.28
16.42	Benzene, 2-ethyl-1,4-dimethyl-	C ₁₀ H ₁₄	0.41
16.62	1-Dodecene	C ₁₂ H ₂₄	0.32
16.72	Benzene, 1-methyl-4-(1-methylethyl)-	C ₁₀ H ₁₄	0.50

17.59	Benzene, 1-methyl-4-(1-methylethyl)-	C ₁₀ H ₁₄	0.53
19.81	p-Cymene	C ₁₀ H ₁₄	0.55
20.03	Naphthalene	C ₁₀ H ₈	0.54
21.37	Naphthalene	C ₁₀ H ₈	0.62
21.95	Phenol, 2-methyl-6-(2-propenyl)-	C ₁₀ H ₁₂ O ₂	0.30
24.82	Naphthalene, 1,2-dihydro-3-methyl-	C ₁₁ H ₁₂	0.18
25.11	Naphthalene, 1,2-dihydro-3-methyl-	C ₁₁ H ₁₂	0.20
26.43	Naphthalene, 1-methyl-	C ₁₁ H ₁₀	0.52
27.08	Bicyclo[4.4.1]undeca-1,3,5,7,9-pentaene	C ₁₁ H ₁₀	0.35
29.83	(1-Methylpenta-1,3-dienyl)benzene	C ₁₂ H ₁₄	0.23
31.72	Naphthalene, 1,8-dimethyl-	C ₁₂ H ₁₂	0.37
36.26	3-(2-Methyl-propenyl)-1H-indene	C ₁₃ H ₁₄	0.18
36.79	3-(2-Methyl-propenyl)-1H-indene	C ₁₃ H ₁₄	0.19
37.52	3-(2-Methyl-propenyl)-1H-indene	C ₁₃ H ₁₄	0.35
38.21	Fluorene	C ₁₃ H ₁₀	0.32
42.66	1-Nonadecene	C ₁₉ H ₃₈	0.52

Table S3

Main identified products from catalytic co-pyrolysis of cellulose and PP with Cat-B

RT (min)	Peak Name	Chem. Formula	Relative Area (%)
2.13	2-Pentene, (E)-	C ₅ H ₁₀	12.67
2.45	2-Pentene, 3-methyl-	C ₆ H ₁₂	9.39
2.73	2-Pentene, 3,4-dimethyl-, (Z)-	C ₇ H ₁₄	3.00
2.86	Benzene	C ₆ H ₆	4.37
3.26	3-Furanmethanol	C ₅ H ₆ O ₂	3.90
4.04	2,4-Pentadien-1-ol, 3-ethyl-, (2Z)-	C ₈ H ₁₆	0.96
4.07	3-Octene, (Z)-	C ₈ H ₁₆	0.74
4.32	Toluene	C ₇ H ₈	5.21
4.84	4-Octene, (E)-	C ₈ H ₁₆	0.68
4.99	cis-4-Decenal	C ₁₀ H ₁₈ O	2.06
5.31	3-Octene, (Z)-	C ₈ H ₁₆	0.62
5.43	3-Decen-1-ol, (Z)-	C ₁₀ H ₂₀ O	0.26
5.95	Furfural	C ₅ H ₄ O ₂	7.34
6.34	Cyclohexanone, 3,5-dimethyl-	C ₈ H ₁₄ O	1.09
6.73	2,4-Pentadien-1-ol, 3-propyl-, (2Z)-	C ₈ H ₁₄ O	0.18
6.92	Ethylbenzene	C ₈ H ₁₀	0.65
7.07	Cyclohexanone, 3,5-dimethyl-	C ₈ H ₁₄ O	0.43
7.24	Benzene, 1,3-dimethyl-	C ₈ H ₁₀	4.26
7.62	3-Octene, 2,2-dimethyl-	C ₁₀ H ₂₀	1.55
8.06	o-Xylene	C ₈ H ₁₀	1.93

8.23	2,2-Dimethyl-3-heptene trans	C ₉ H ₁₈	0.26
8.47	Furfural	C ₅ H ₄ O ₂	0.28
9.36	2-Pentene, 4,4-dimethyl-, (Z)-	C ₇ H ₁₄	0.36
9.89	3-Decyn-2-ol	C ₁₀ H ₁₈ O	0.38
10.92	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	2.09
11.06	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	0.39
11.30	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	0.82
11.68	Benzene, 1-ethyl-2-methyl-	C ₉ H ₁₂	0.37
11.83	Phenol	C ₆ H ₆ O	0.53
12.42	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	3.10
13.65	Mesitylene	C ₉ H ₁₂	1.00
14.26	Benzene, 1-propenyl-	C ₉ H ₁₀	0.70
14.70	Indene	C ₉ H ₈	0.54
15.24	Phenol, 3-methyl-	C ₇ H ₈ O	0.36
15.42	Benzene, 1-ethyl-2,4-dimethyl-	C ₁₀ H ₁₄	0.64
16.40	p-Cymene	C ₁₀ H ₁₄	0.42
16.49	Benzene, cyclopropyl-	C ₉ H ₁₀	0.19
16.69	p-Cymene	C ₁₀ H ₁₄	0.86
18.19	Benzene, 1-ethyl-3,5-dimethyl-	C ₁₀ H ₁₄	0.39
18.36	p-Cymene	C ₁₀ H ₁₄	0.54
19.25	Indane	C ₉ H ₁₀	0.24
19.66	Benzene, cyclopropyl-	C ₉ H ₁₀	0.57
19.79	Benzene, 1,2,3,5-tetramethyl-	C ₁₀ H ₁₄	0.78
20.01	1H-Indene, 3-methyl-	C ₁₀ H ₁₀	0.79
21.36	Naphthalene	C ₁₀ H ₈	1.35
21.55	1(2H)-Naphthalenone, 3,4-dihydro-5,7-dimethyl-	C ₁₂ H ₁₄ O	0.38
21.71	Benzene, 1,3-bis(1-methylethyl)-	C ₁₂ H ₁₈	0.27
24.82	2-Cyclohexen-1-one, 3-phenyl-	C ₁₂ H ₁₂ O	0.31
25.10	Naphthalene, 1,2-dihydro-3-methyl-	C ₁₁ H ₁₂	0.25
24.82	2-Cyclohexen-1-one, 3-phenyl-	C ₁₂ H ₁₂ O	0.29
25.72	Phenol, 2-methyl-6-(2-propenyl)-	C ₁₀ H ₁₂ O	0.76
26.42	Benzocycloheptatriene	C ₁₁ H ₁₀	0.82
27.08	Bicyclo[4.4.1]undeca-1,3,5,7,9-pentaene	C ₁₁ H ₁₀	0.61
29.84	Naphthalene, 1-(1-methylethyl)-	C ₁₃ H ₁₄	0.37
31.71	Naphthalene, 1,8-dimethyl-	C ₁₂ H ₁₂	0.54
37.48	Naphthalene, 1,6,7-trimethyl-	C ₁₃ H ₁₄	0.26
38.22	Fluorene	C ₁₃ H ₁₀	0.27
42.00	Naphthalene, 1,2,3,4-tetramethyl-	C ₁₄ H ₁₆	0.24
42.46	9H-Fluoren-9-one	C ₁₃ H ₈ O	0.16
42.62	n-Pentadecanol	C ₁₅ H ₂₂ O	1.10
42.88	Tetradecane	C ₁₄ H ₃₀	0.45

Table S4

Main identified products from catalytic co-pyrolysis of cellulose and PP with Cat-C

RT (min)	Peak Name	Chem. Formula	Relative Area (%)
2.14	2-Butene, 2-methyl-	C ₅ H ₁₀	9.14
2.46	2-Pentene, 3-methyl-	C ₆ H ₁₂	11.54
2.75	2,4-Hexadiene	C ₆ H ₁₀	4.94
2.87	Benzene	C ₆ H ₆	4.00
3.12	Cyclopentane, 1,3-dimethyl-, cis-	C ₇ H ₁₄	0.63
3.26	3-Furanmethanol	C ₅ H ₆ O ₂	4.05
3.86	3-Cyclohexene-1-acetaldehyde, π 4-dimethyl-	C ₁₀ H ₁₆ O	1.21
4.11	3-Octene, (Z)-	C ₈ H ₁₆	3.26
4.34	Toluene	C ₇ H ₈	4.64
4.87	4-Octene, (E)-	C ₈ H ₁₆	0.66
5.03	4-Octene, (E)-	C ₈ H ₁₆	1.19
5.11	4-Octene, (E)-	C ₈ H ₁₆	0.92
5.34	2,2-Dimethyl-3-heptene trans	C ₉ H ₁₈	1.03
6.00	2,2-Dimethyl-3-heptene trans	C ₉ H ₁₈	7.27
6.29	2,4-Dimethyl-1-heptene	C ₉ H ₁₈	1.75
6.38	4-Nonene	C ₉ H ₁₈	1.80
6.59	Isooctanol	C ₈ H ₁₈ O	1.26
6.95	Ethylbenzene	C ₈ H ₁₀	0.70
7.09	Cyclohexanone, 3,5-dimethyl-	C ₈ H ₁₄ O	0.58
7.27	Benzene, 1,3-dimethyl-	C ₈ H ₁₀	2.95
7.66	Cyclohexane, (2-methylpropyl)-	C ₁₀ H ₂₀	2.04
7.88	2-Propenoic acid, 2-methylpropyl ester	C ₇ H ₁₂ O ₂	0.48
8.09	o-Xylene	C ₈ H ₁₀	1.52
8.26	Cyclohexane, propyl-	C ₉ H ₁₈	0.42
8.37	Phenol, 3-ethyl-	C ₈ H ₁₀ O ₂	0.24
8.48	Furan, 2,5-dimethyl-	C ₆ H ₈ O	0.25
9.38	3-Penten-2-one, 4-methyl-	C ₆ H ₁₀ O	0.61
9.93	1-Dodecene	C ₁₂ H ₂₄	0.75
10.29	4-Isopropylcyclohexanone	C ₉ H ₁₆ O	0.25
10.48	1-Dodecanol	C ₁₂ H ₂₆ O	0.39
10.74	1-Decanol	C ₁₀ H ₂₂ O	0.54
10.95	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	2.07
11.33	Benzene, 1,3,5-trimethyl-	C ₉ H ₁₂	0.66
11.86	Phenol	C ₆ H ₆ O	0.35
12.06	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.33
12.44	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	2.21
13.67	Benzene, 1,2,4-trimethyl-	C ₉ H ₁₂	0.73
14.28	Indane	C ₉ H ₁₀	0.67
14.71	Indane	C ₉ H ₁₀	0.44

15.27	2(3H)-Furanone,4,5-dihydro-4-(2-methyl-3-methylenebut-4-yl)-	C ₁₀ H ₁₆ O ₂	0.41
16.29	Benzene, 1-ethyl-2,4-dimethyl-	C ₁₀ H ₁₄	0.22
16.42	Benzene, 1-methyl-4-(1-methylethyl)-	C ₁₀ H ₁₄	0.50
16.65	1-Tridecene	C ₁₃ H ₂₆	0.42
16.71	Benzene, 1-methyl-2-(1-methylethyl)-	C ₁₀ H ₁₄	0.42
18.22	Benzene, 1,2,4,5-tetramethyl-	C ₁₀ H ₁₄	0.40
18.38	Benzene, 1,2,4,5-tetramethyl-	C ₁₀ H ₁₄	0.41
19.81	Benzene, 1,2,4,5-tetramethyl-	C ₁₀ H ₁₄	0.61
20.02	4,7-Methano-1H-inden-1-ol,3a,4,7,7a-tetrahydro-, acetate	C ₁₂ H ₁₄ O ₂	0.51
21.38	Naphthalene	C ₁₀ H ₈	0.85
21.72	Benzene, 1,3-bis(1-methylethyl)-	C ₁₂ H ₁₈	0.22
25.73	Pentadecane	C ₁₅ H ₃₂	0.59
26.20	1-Pentadecene	C ₁₅ H ₃₀	0.19
26.43	Naphthalene, 2-methyl-	C ₁₁ H ₁₀	0.58
26.58	1-Pentadecene	C ₁₅ H ₃₀	0.21
26.87	1-Tetradecene	C ₁₄ H ₂₈	0.35
27.09	Naphthalene, 2-methyl-	C ₁₁ H ₁₀	0.27
29.85	Azulene	C ₁₀ H ₈	0.23
31.72	Naphthalene, 1-(1-methylethyl)-	C ₁₃ H ₁₄	0.31
36.27	Naphthalene, 1,6,7-trimethyl-	C ₁₃ H ₁₄	0.19
37.00	1-Nonadecene	C ₁₉ H ₃₈	0.21
38.23	Fluorene	C ₁₃ H ₁₀	0.22
38.92	1-Hexadecanol, 2-methyl-	C ₁₇ H ₃₆ O	0.18
42.02	1-Nonadecene	C ₁₉ H ₃₈	0.19

Table S5

Main identified products from catalytic co-pyrolysis of cellulose and PP with Cat-D

RT (min)	Peak Name	Chem. Formula	Relative Area (%)
1.99	2-Butene	C ₄ H ₈	1.53
2.13	2-Pentene, (E)-	C ₅ H ₁₀	9.66
2.27	Cyclopropane, 1,2,3-trimethyl-	C ₆ H ₁₂	1.46
2.36	1-Pentene, 2-methyl-	C ₆ H ₁₂	2.65
2.44	2-Pentene, 3-methyl-	C ₆ H ₁₂	8.94
2.73	2-Pentene, 2,4-dimethyl-	C ₇ H ₁₄	5.86
2.85	Benzene	C ₆ H ₆	2.08
3.07	1-Butanol	C ₄ H ₁₀ O	0.88
3.24	3-Furanmethanol	C ₅ H ₆ O ₂	4.04
3.83	Cyclohexane, ethyl-	C ₈ H ₁₆	1.10
4.08	3-Octene, (Z)-	C ₈ H ₁₆	2.40
4.19	3-Octene, (Z)-	C ₈ H ₁₆	0.76

4.32	Toluene	C ₇ H ₈	2.30
4.71	1,2-Cyclopentanedione, 3-methyl-	C ₆ H ₈ O ₂	0.30
4.85	3-Octene, (E)-	C ₈ H ₁₆	0.97
5.03	cis-4-Decenal	C ₁₀ H ₁₈ O	2.45
5.32	2,2-Dimethyl-3-heptene trans	C ₉ H ₁₈	0.81
5.97	Cyclohexane, propyl-	C ₉ H ₁₈	9.86
6.25	2,4-Dimethyl-1-heptene	C ₉ H ₁₈	2.08
6.36	trans--4-Nonene	C ₉ H ₁₈	2.07
6.58	1-Hexyn-3-ol, 3-methyl-	C ₇ H ₁₂ O	1.69
6.76	Ethanone, 1-(1-cyclohexen-1-yl)-	C ₈ H ₁₂ O	0.80
6.94	Benzene, 1,3-dimethyl-	C ₈ H ₁₀	1.06
7.10	di-t-Butylacetylene	C ₁₀ H ₁₈	0.90
7.18	Cyclohexanone, 3,5-dimethyl-	C ₈ H ₁₄ O	1.21
7.30	o-Xylene	C ₈ H ₁₀	0.98
7.64	Cyclohexane, (2-methylpropyl)-	C ₁₀ H ₂₀	2.53
7.87	1,4-Cyclohexadiene, 1-methyl-4-(1-methylethyl)-	C ₁₀ H ₁₆	0.60
8.08	o-Xylene	C ₈ H ₁₀	0.89
8.73	3-Decyn-2-ol	C ₁₀ H ₁₈ O	0.23
9.02	Flamenol	C ₇ H ₈ O ₂	0.21
9.38	Cyclopentanone, 2-methyl-	C ₆ H ₁₀ O	0.66
9.91	4-Isopropylcyclohexanone	C ₉ H ₁₆ O	0.67
10.30	Phenol, 3,4-dimethyl-	C ₈ H ₁₀ O	0.26
10.47	cis-3-Decene	C ₁₀ H ₂₀	0.46
10.73	4-Isopropylcyclohexanone	C ₉ H ₁₆ O	0.64
10.93	2-Furancarboxaldehyde, 5-methyl-	C ₆ H ₆ O ₂	2.65
11.32	Benzene, 1,3,5-trimethyl-	C ₉ H ₁₂	0.39
11.86	2-Norbornyl acetate	C ₉ H ₁₄ O ₂	0.53
12.05	5-Undecene, (Z)-	C ₁₁ H ₂₂	0.38
12.43	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	1.25
12.68	2,4-Pentadien-1-ol, 3-pentyl-, (2Z)-	C ₁₀ H ₁₈ O	0.27
12.74	2-Propenoic acid, 2-methyl-, ethyl ester	C ₆ H ₁₀ O ₂	0.26
13.11	2,3,4-Trimethyl-hex-3-enal	C ₉ H ₁₆ O	0.35
13.67	Benzene, 1,4-diethyl-	C ₁₀ H ₁₄	0.33
14.12	D-Limonene	C ₁₀ H ₁₆	0.71
14.29	1-Undecene	C ₁₁ H ₂₂	0.43
14.71	Indene	C ₉ H ₈	0.30
14.95	1-Undecene	C ₁₁ H ₂₂	0.47
15.09	1-Undecene	C ₁₁ H ₂₂	0.41
15.26	1-Tridecene	C ₁₃ H ₂₆	0.52
15.36	1-Tetradecanol	C ₁₄ H ₃₀ O	0.23
15.50	1-Dodecene	C ₁₂ H ₂₄	0.36
15.65	1-Tetradecanol	C ₁₄ H ₃₀ O	0.56
16.41	Benzene, 1-ethyl-2,4-dimethyl-	C ₁₀ H ₁₄	0.62
16.63	1-Dodecanol	C ₁₂ H ₂₆ O	0.51

17.71	1-Tridecene	C ₁₃ H ₂₆	0.48
23.76	Tetradecane	C ₁₄ H ₃₀	0.18
26.17	1-Pentadecene	C ₁₅ H ₃₀	0.32
34.96	n-Pentadecanol	C ₁₅ H ₃₂ O	0.16
35.88	n-Heptadecanol-1	C ₁₇ H ₃₆ O	0.25
38.58	1-Nonadecene	C ₁₉ H ₃₈	0.30
38.88	1-Decanol, 2-hexyl-	C ₁₆ H ₃₄ O	0.50
46.14	1-Nonadecene	C ₁₉ H ₃₈	0.31

Table S6

All peaks for the catalytic co-pyrolysis of cellulose and PP with different (Ni)-MCM-41 catalysts

M		Cat-A		Cat-B		Cat-C		Cat-D	
RT (min)	Area (%)	RT (min)	Area (%)	RT (min)	Area (%)	RT (min)	Area (%)	RT (min)	Area (%)
2.17	10.41	1.99	1.70	2.13	12.67	2.14	9.14	1.99	1.53
2.50	6.04	2.13	11.62	2.45	9.39	2.46	11.54	2.13	9.66
2.78	2.14	2.45	11.17	2.73	3.00	2.75	4.94	2.27	1.46
2.86	0.53	2.73	5.54	2.86	4.37	2.87	4.00	2.36	2.65
3.13	0.53	2.87	4.25	3.08	0.55	3.12	0.63	2.44	8.94
3.28	5.57	3.08	1.34	3.25	3.90	3.26	4.05	2.73	5.86
3.90	0.79	3.25	3.87	3.84	1.14	3.86	1.21	2.85	2.08
4.13	0.89	3.85	0.97	4.04	0.96	4.11	3.26	3.07	0.88
4.38	2.86	4.09	2.12	4.07	0.74	4.34	4.64	3.24	4.04
4.79	0.24	4.20	0.46	4.32	5.21	4.72	0.29	3.83	1.10
5.06	3.15	4.35	4.86	4.70	0.20	4.87	0.66	4.08	2.40
5.38	1.56	4.58	0.22	4.84	0.68	5.03	1.19	4.19	0.76
5.87	0.33	4.72	0.26	4.99	2.06	5.11	0.92	4.32	2.30
6.06	12.53	4.87	0.63	5.31	0.62	5.34	1.03	4.71	0.30
6.33	1.02	5.06	2.89	5.43	0.26	5.81	0.33	4.85	0.97
6.43	0.89	5.33	0.59	5.95	7.34	6.00	7.27	5.03	2.45
6.65	1.17	5.47	0.22	6.24	0.70	6.29	1.75	5.32	0.81
6.83	0.32	6.02	7.89	6.34	1.09	6.38	1.80	5.46	0.26
6.99	0.53	6.26	1.11	6.56	0.49	6.59	1.26	5.81	0.34
7.14	0.41	6.37	1.39	6.73	0.18	6.78	0.41	5.97	9.86
7.36	3.44	6.60	1.05	6.92	0.65	6.95	0.70	6.25	2.08
7.71	3.05	6.77	0.46	7.07	0.43	7.09	0.58	6.36	2.07
7.94	0.95	6.96	1.10	7.24	4.26	7.27	2.95	6.58	1.69
8.15	1.20	7.09	0.75	7.62	1.55	7.66	2.04	6.76	0.80
8.32	0.40	7.30	3.46	7.86	0.38	7.88	0.48	6.94	1.06
8.43	0.18	7.66	1.31	8.06	1.93	8.09	1.52	7.10	0.90
8.71	0.55	7.88	0.36	8.23	0.26	8.26	0.42	7.18	1.21

9.23	0.25	8.10	1.68	8.47	0.28	8.37	0.24	7.30	0.98
9.44	0.66	8.27	0.24	8.70	0.19	8.48	0.25	7.64	2.53
9.98	0.39	8.38	0.17	9.36	0.36	8.74	0.26	7.87	0.60
10.36	0.38	8.53	0.20	9.89	0.38	9.17	0.22	8.08	0.89
10.52	0.68	8.75	0.19	10.45	0.22	9.38	0.61	8.26	0.40
10.79	0.66	9.38	0.49	10.71	0.30	9.93	0.75	8.36	0.18
11.00	2.98	9.93	0.30	10.92	2.09	10.29	0.25	8.73	0.23
11.39	1.00	10.48	0.21	11.06	0.39	10.48	0.39	9.02	0.21
11.68	0.23	10.73	0.26	11.30	0.82	10.74	0.54	9.16	0.18
11.77	0.32	10.97	2.50	11.68	0.37	10.95	2.07	9.38	0.66
11.93	0.40	11.10	0.36	11.83	0.53	11.33	0.66	9.91	0.67
12.11	0.59	11.34	0.64	12.42	3.10	11.61	0.21	10.30	0.26
12.51	3.55	11.72	0.27	12.67	0.36	11.71	0.38	10.47	0.46
12.75	0.73	11.89	0.46	13.09	0.38	11.86	0.35	10.73	0.64
13.19	0.24	12.45	2.28	13.65	1.00	12.06	0.33	10.80	0.29
13.54	0.20	12.70	0.28	14.26	0.70	12.44	2.21	10.93	2.65
13.74	0.95	13.12	0.20	14.70	0.54	12.69	0.31	11.32	0.39
14.36	0.76	13.68	0.71	14.94	0.23	12.76	0.28	11.86	0.53
14.78	0.62	13.92	0.17	15.10	0.36	13.05	0.17	12.05	0.38
15.02	0.42	14.29	0.46	15.24	0.36	13.12	0.37	12.43	1.25
15.17	0.50	14.73	0.51	15.34	0.25	13.67	0.73	12.68	0.27
15.33	0.30	14.96	0.34	15.42	0.64	14.28	0.67	12.74	0.26
15.57	0.20	15.12	0.41	15.63	0.19	14.71	0.44	13.11	0.35
15.73	0.64	15.28	0.35	15.77	0.26	14.96	0.35	13.46	0.22
15.85	0.28	15.36	0.26	16.28	0.37	15.11	0.41	13.67	0.33
16.36	0.20	15.44	0.56	16.40	0.42	15.27	0.41	14.12	0.71
16.49	0.32	15.66	0.27	16.49	0.19	15.37	0.27	14.29	0.43
16.78	0.59	15.79	0.19	16.69	0.86	15.44	0.34	14.71	0.30
17.13	0.20	16.31	0.28	17.24	0.27	15.50	0.36	14.95	0.47
17.32	0.40	16.42	0.41	17.38	0.19	15.66	0.48	15.09	0.41
17.48	0.57	16.62	0.32	17.57	0.67	15.78	0.22	15.26	0.52
17.66	0.32	16.72	0.50	17.71	0.26	16.29	0.22	15.36	0.23
17.79	0.28	17.26	0.23	17.81	0.30	16.42	0.50	15.43	0.18
18.08	0.18	17.41	0.19	18.19	0.39	16.65	0.42	15.50	0.36
18.28	0.58	17.59	0.53	18.36	0.54	16.71	0.42	15.65	0.56
18.44	0.71	17.73	0.22	19.25	0.24	17.26	0.36	15.78	0.17
19.75	0.38	17.82	0.26	19.66	0.57	17.41	0.43	16.41	0.62
19.88	0.60	18.22	0.30	19.79	0.78	17.48	0.30	16.63	0.51
20.09	0.19	18.37	0.38	19.93	0.19	17.59	0.36	16.70	0.27
20.36	0.23	19.27	0.16	20.01	0.79	17.72	0.37	17.21	0.39
20.70	0.19	19.68	0.40	20.26	0.28	17.85	0.21	17.39	0.80
21.02	0.20	19.81	0.55	20.94	0.22	18.22	0.40	17.58	0.32
21.19	0.22	20.03	0.54	21.12	0.31	18.38	0.41	17.71	0.48
21.44	0.27	21.37	0.62	21.36	1.35	18.70	0.20	17.83	0.24

22.05	0.21	21.55	0.33	21.55	0.38	19.27	0.18	18.00	0.23
22.54	0.19	21.72	0.25	21.71	0.27	19.68	0.33	18.25	0.26
22.91	0.17	21.95	0.30	21.95	0.37	19.81	0.61	19.76	0.22
23.65	0.26	24.82	0.18	22.02	0.20	20.02	0.51	19.81	0.17
23.84	0.23	25.11	0.20	24.81	0.31	21.38	0.85	20.01	0.18
24.89	0.30	25.22	0.18	25.10	0.25	21.56	0.29	20.11	0.17
25.17	0.19	25.51	0.18	24.81	0.29	21.72	0.22	20.94	0.18
25.58	0.58	25.73	0.59	25.72	0.76	21.97	0.47	21.94	0.34
25.80	0.99	26.43	0.52	26.42	0.82	23.78	0.26	23.09	0.18
26.25	0.39	27.08	0.35	26.86	0.17	25.52	0.36	23.18	0.21
26.49	0.53	29.83	0.23	27.08	0.61	25.73	0.59	23.76	0.18
26.64	0.33	31.72	0.37	29.84	0.37	26.20	0.19	25.50	0.34
26.93	0.50	34.23	0.18	31.71	0.54	26.43	0.58	25.73	0.26
27.16	0.20	35.88	0.25	31.88	0.17	26.58	0.21	26.17	0.32
27.67	0.23	36.26	0.18	31.88	0.22	26.87	0.35	26.56	0.18
28.40	0.25	36.79	0.19	34.79	0.24	27.09	0.27	26.85	0.26
29.92	0.28	37.52	0.35	34.97	0.29	27.61	0.17	27.23	0.19
30.66	0.18	38.04	0.20	35.89	0.19	28.32	0.21	27.59	0.19
31.79	0.38	38.21	0.32	37.48	0.26	29.85	0.23	30.83	0.18
31.96	0.17	38.60	0.17	37.81	0.16	31.72	0.31	31.18	0.19
32.28	0.22	38.90	0.26	38.22	0.27	34.59	0.26	34.22	0.23
32.62	0.17	38.98	0.21	42.00	0.24	35.90	0.31	34.96	0.16
34.06	0.21	42.01	0.23	42.46	0.16	36.27	0.19	35.88	0.25
34.29	0.22	42.66	0.52	42.53	0.20	37.00	0.21	38.58	0.30
34.64	0.31	42.83	0.18	42.62	1.10	37.56	0.29	38.88	0.50
35.34	0.18	43.05	0.27	42.88	0.45	38.23	0.22	42.60	0.60
35.96	0.46	48.20	0.36	43.05	0.46	38.92	0.18	42.81	0.22
36.08	0.21			43.46	0.19	42.02	0.19	42.87	0.20
36.33	0.42			45.34	0.18	42.65	0.46	44.38	0.17
36.88	0.36			46.15	0.18	42.83	0.18	44.87	0.19
37.07	0.43			48.21	0.93	43.85	0.23	45.33	0.23
37.45	0.24			51.31	0.26	43.95	0.20	46.14	0.31
37.62	0.49					45.16	0.18		
38.12	0.24					45.36	0.22		
38.30	0.32					48.21	0.36		
38.97	0.19								
39.06	0.19								
39.28	0.17								
40.96	0.18								
42.08	0.25								
42.72	0.49								
42.90	0.29								
43.92	0.18								
44.01	0.17								

44.24	0.17			
45.41	0.26			
48.27	0.25			

Table S7

Main identified products from catalytic pyrolysis of cellulose with catalyst M

RT (min)	Peak Name	Chem. Formula	Relative Area (%)
2.085	2H-Pyran-2-one, 5,6-dihydro-	C ₅ H ₆ O ₂	7.90
2.418	3-Cyclopentene-1,2-diol, cis-	C ₅ H ₈ O ₂	12.55
2.748	2,6-Cyclooctadien-1-ol	C ₈ H ₁₂ O	0.93
2.884	Benzene	C ₆ H ₆	0.89
3.027	Benzene	C ₆ H ₆	0.37
3.285	Furfural	C ₅ H ₄ O ₂	1.77
3.544	2-Vinylfuran	C ₆ H ₆ O	0.94
3.996	1,6-Octadiene, 3,7-dimethyl-	C ₁₀ H ₁₈	0.89
4.367	Cyclobutene, 2-propenylidene-	C ₇ H ₈	1.77
5.04	Maleic anhydride	C ₄ H ₂ O ₃	11.73
5.472	3-Furaldehyde	C ₅ H ₄ O ₂	1.01
6.074	Furfural	C ₅ H ₄ O ₂	23.08
6.186	Furfural	C ₅ H ₄ O ₂	1.40
6.748	Phenol, 3-methyl-	C ₇ H ₈ O	0.31
7.088	Furan, 2-propyl-	C ₇ H ₁₀ O	1.32
7.302	o-Xylene	C ₈ H ₁₀	0.27
7.646	4-Cyclopentene-1,3-dione	C ₅ H ₄ O ₂	1.19
8.084	Styrene	C ₈ H ₈	0.63
8.52	Furan, 2,5-dimethyl-	C ₆ H ₈ O	0.43
8.724	Hepten-2-yl 9-Tetradecen-1-ol, (E)-, 6-methyl-5-	C ₁₄ H ₂₈ O	0.77
9.37	Cyclopentanone, 2-methyl-	C ₆ H ₁₀ O	0.90
10.955	2-Furancarboxaldehyde, 5-methyl-	C ₆ H ₆ O ₂	6.33
11.877	Phenol	C ₆ H ₆ O	1.48
12.496	Benzofuran	C ₈ H ₆ O	1.30
12.7	2-Hydroxy-6-methyl-3-cyclohexen-1-carboxylic acid	C ₈ H ₁₂ O ₃	0.34
13.081	1,6-Cyclodecanediol	C ₁₀ H ₂₀ O ₂	0.08
13.441	6-Hydroxymethyl-5-methyl-bicyclo[3.1.0]hexan-2-one	C ₈ H ₁₂ O ₂	0.17
13.669	Benzene, 1,2,3-trimethyl-	C ₉ H ₁₂	0.11
13.849	Decanal	C ₁₀ H ₂₀ O	0.47
14.291	Indane	C ₉ H ₁₀	0.36
14.465	1,2-Benzenedicarboxaldehyde	C ₈ H ₆ O ₂	0.13
14.73	Indene	C ₉ H ₈	0.87
14.853	Bicyclo [2.2.1] heptane-2,3-dione, 1,7,7-trimethyl-, (1S)-	C ₁₀ H ₁₄ O ₂	0.19

14.948	Hexane, 2,4-dimethyl-	C ₈ H ₁₈	0.21
15.203	Benzaldehyde, 3-hydroxy-	C ₇ H ₆ O ₂	0.09
15.281	Phenol, 3-methyl-	C ₇ H ₈ O	0.43
15.791	Acetophenone	C ₈ H ₈ O	0.25
16.363	Phenol, 3-methyl-	C ₇ H ₈ O	0.42
16.556	Tetracyclo [4.4.1.1(7,10).0(2,5)] dodec-3-en-11-ol	C ₁₂ H ₁₆ O	0.43
17.257	2H-Inden-2-one, 1,3-dihydro-	C ₉ H ₈ O	0.26
17.601	Benzofuran, 7-methyl-	C ₉ H ₈ O	0.37
17.801	Benzofuran, 2-methyl-	C ₉ H ₈ O	0.71
18.016	Benzene, ethoxy-	C ₈ H ₁₀ O	0.12
18.985	9-Oxabicyclo [6.1.0] nonan-4-ol	C ₈ H ₁₄ O ₂	0.17
19.254	5,7-Dodecadiyn-1,12-diol	C ₁₂ H ₁₈ O ₂	0.10
19.668	1H-Indene, 3-methyl-	C ₁₀ H ₁₀	0.19
19.771	1H-Indene, 3-methyl-	C ₁₀ H ₁₀	0.27
20.032	Tetracyclo [5.3.0.0<2,6>.0<3,10>] deca-4,8-diene	C ₁₀ H ₁₀	0.34
21.121	Furan, 2-(2-furanylmethyl)-5-methyl-	C ₁₀ H ₁₀ O ₂	0.21
21.491	Nonanal	C ₉ H ₁₈ O	1.30
24.913	Panaxydol	C ₁₇ H ₂₄ O ₂	0.12
25.137	o-[(1,2,3,4-tetrahydro-2-naphthyl) methyl]-	C ₂₀ H ₂₂ O ₂	0.14
25.192	Naphthalene, 1,2-dihydro-3-methyl-	C ₁₁ H ₁₂	0.09
25.478	2-Naphthalenol	C ₁₀ H ₈ O	0.18
25.637	1H-Inden-1-one, 2,3-dihydro-	C ₉ H ₈ O	0.37
26.41	Bicyclo [4.4.1] undeca-1,3,5,7,9-pentaene	C ₁₁ H ₁₀	0.36
26.852	Tridecane	C ₁₂ H ₂₈	0.18
27.052	Bicyclo [4.4.1] undeca-1,3,5,7,9-pentaene	C ₁₁ H ₁₀	0.58
27.369	3-(1-Cyclopentenyl) furan	C ₉ H ₁₀ O	0.40
29.093	Naphthalene, 1,2,3,4-tetrahydro-1,4,6-trimethyl-	C ₁₃ H ₁₈	0.26
30.549	4H-1-Benzopyran-4-one	C ₉ H ₆ O ₂	0.38
32.174	2-Furancarboxaldehyde, 5-(2-furanylmethyl)-	C ₁₀ H ₈ O ₃	0.48
33.97	2H-1,5-Benzodioxepin, 3,4-dihydro-3-methylene-	C ₁₀ H ₁₀ O ₂	0.75
34.957	n-Tridecan-1-ol	C ₁₃ H ₂₈ O	0.24
35.848	2-Furancarboxaldehyde, 5-[(5-methyl-2-furanyl) methyl]-	C ₁₁ H ₁₀ O ₃	0.49
38.177	Fluorene	C ₁₃ H ₁₀	0.23
38.946	Fluorene	C ₁₃ H ₁₀	0.13
39.946	Benzophenone	C ₁₃ H ₁₀ O	0.16
42.572	1-Hexadecanol, 2-methyl-	C ₁₇ H ₃₆ O	0.23

Table S8

Main identified products from catalytic pyrolysis of PP with catalyst M

RT (min)	Peak Name	Chem. Formula	Relative Area (%)
2.112	2-Pentene, (E)-	C ₅ H ₁₀	4.77

2.187	2-Butene, 2-methyl-	C ₅ H ₁₀	7.28
2.503	2-Pentene, 3-methyl-	C ₆ H ₁₂	12.39
2.792	1-Butene, 2-ethyl-3-methyl-	C ₇ H ₁₄	3.58
2.874	3-Hexene, 2-methyl-, (Z)-	C ₇ H ₁₄	3.44
3.132	(Z)-2-Heptene	C ₇ H ₁₄	2.49
3.275	3-Hexene, 3-methyl-, (Z)-	C ₇ H ₁₄	8.49
3.891	1-Dodecene	C ₈ H ₁₆	0.95
4.081	3-Octene, (Z)-	C ₈ H ₁₆	3.38
4.21	2-Hexene, 3,5-dimethyl-	C ₈ H ₁₆	2.43
4.445	1-Dodecene	C ₈ H ₁₆	1.55
4.877	4-Octene, (E)-	C ₈ H ₁₆	2.95
5.122	3-Octene, (E)-	C ₈ H ₁₆	3.84
5.333	2-Hexene, 3,5-dimethyl-	C ₈ H ₁₆	1.32
5.479	1-Dodecene	C ₈ H ₁₆	0.38
6.023	2,3-Dimethyl-3-heptene	C ₉ H ₁₈	1.75
6.404	2,3-Dimethyl-3-heptene	C ₉ H ₁₈	1.72
6.601	trans--4-Nonene	C ₉ H ₁₈	2.18
6.802	4-Nonene	C ₉ H ₁₈	0.77
6.897	trans--4-Nonene	C ₉ H ₁₈	0.77
7.217	3-Nonene, (E)-	C ₉ H ₁₈	1.82
7.336	4-Nonene	C ₉ H ₁₈	1.16
7.622	4-Nonene	C ₉ H ₁₈	1.53
7.928	trans--4-Nonene	C ₉ H ₁₈	1.48
8.112	Ethylbenzene	C ₈ H ₁₀	0.57
8.268	3-Heptene, 4-ethyl-	C ₉ H ₁₈	1.14
8.401	trans-2-Methyl-3-octene	C ₉ H ₁₈	0.87
8.68	trans--4-Nonene	C ₉ H ₁₈	0.60
8.965	3-Octene, 4-ethyl-	C ₁₀ H ₂₀	0.32
9.047	3-Octene, 2,2-dimethyl-	C ₁₀ H ₂₀	0.25
9.196	3-Octene, 2,2-dimethyl-	C ₁₀ H ₂₀	0.25
9.424	3-Octene, 2,2-dimethyl-	C ₁₀ H ₂₀	0.22
9.503	3-Octene, 2,2-dimethyl-	C ₁₀ H ₂₀	0.14
9.928	2-Decene, (Z)-	C ₁₀ H ₂₀	0.91
10.332	3-Heptene, 4-propyl-	C ₁₀ H ₂₀	0.30
10.479	4-Octene, 2,6-dimethyl-, [S-(E)]-	C ₁₀ H ₂₀	0.80
10.768	cis-3-Decene	C ₁₀ H ₂₀	0.84
10.856	cis-4-Decene	C ₁₀ H ₂₀	0.28
10.982	3-Octene, 2,2-dimethyl-	C ₁₀ H ₂₀	0.29
11.071	trans-3-Decene	C ₁₀ H ₂₀	0.90
11.377	cis-3-Decene	C ₁₀ H ₂₀	0.69
11.638	2-Decene, (Z)-	C ₁₀ H ₂₀	0.66
12.091	4-Octene, 2,6-dimethyl-, [S-(E)]-	C ₁₀ H ₂₀	0.84
12.468	Mesitylene	C ₉ H ₁₂	1.11
12.713	2-Nonene, 2-methyl-	C ₁₀ H ₂₀	0.69

13.135	4-Undecene, (Z)-	C ₁₁ H ₂₂	0.39
13.509	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.32
13.696	1-Decene, 5-methyl-	C ₁₁ H ₂₂	0.43
13.982	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.24
14.332	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.42
14.723	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.26
14.934	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.60
15.142	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.63
15.301	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.26
15.407	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.32
15.638	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.53
15.815	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.25
15.944	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.41
16.505	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.27
16.74	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.37
17.244	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.31
17.454	3-Undecene, (Z)-	C ₁₁ H ₂₂	0.49
17.743	1-Dodecene	C ₁₂ H ₂₄	0.36
18.243	1-Dodecene	C ₁₂ H ₂₄	0.28
18.407	1-Dodecene	C ₁₂ H ₂₄	0.23
19.845	1-Dodecene	C ₁₂ H ₂₄	0.44
20.036	1-Dodecene	C ₁₂ H ₂₄	0.24
20.209	1-Dodecene	C ₁₂ H ₂₄	0.17
20.43	1-Dodecene	C ₁₂ H ₂₄	0.18
21.957	3-Tridecene, (E)-	C ₁₃ H ₂₆	0.29
22.134	Cyclohexane, 2-butyl-1,1,3-trimethyl-	C ₁₃ H ₂₆	0.16
25.542	7-Tetradecene, (E)-	C ₁₄ H ₂₈	0.17
25.753	7-Tetradecene, (E)-	C ₁₄ H ₂₈	0.28
26.209	7-Tetradecene, (E)-	C ₁₄ H ₂₈	0.19
26.457	7-Tetradecene, (E)-	C ₁₄ H ₂₈	0.20
27.253	7-Tetradecene, (E)-	C ₁₄ H ₂₈	0.17
39.235	1-Octadecene	C ₁₈ H ₃₆	0.11

Table S9

Main identified products from catalytic pyrolysis of cellulose with Cat-C

RT (min)	Peak Name	Chem. Formula	Relative Area (%)
2.194	3-Penten-1-ol, (Z)-	C ₅ H ₁₀ O	6.45
2.483	Furan, 3-methyl-	C ₅ H ₆ O	10.63
2.537	Furan, 3-methyl-	C ₅ H ₆ O	6.47
2.786	1,4-Hexadiene	C ₆ H ₁₀	2.93
2.928	Benzene	C ₆ H ₆	5.02

3.102	2-Hexene	C ₆ H ₁₂	1.99
3.343	Furan, 2,5-dimethyl-	C ₆ H ₈ O	5.13
3.595	2-Vinylfuran	C ₆ H ₆ O	1.90
4.415	Cyclobutene, 2-propenylidene-	C ₇ H ₈	2.80
5.112	cis-4-Decenal	C ₁₀ H ₁₈ O	2.53
5.537	Furfural	C ₅ H ₄ O ₂	0.55
6.173	Furfural	C ₅ H ₄ O ₂	17.98
6.275	Furfural	C ₅ H ₄ O ₂	3.45
6.816	Furan, 2-(2-propenyl)-	C ₇ H ₈ O	0.42
7.357	p-Xylene	C ₈ H ₁₀	0.66
7.741	Phenol	C ₆ H ₆ O	0.42
8.153	Styrene	C ₈ H ₈	1.07
8.598	Furan, 2,5-dimethyl-	C ₆ H ₈ O	2.06
8.809	2,4-Hexadiene, 2,5-dimethyl-	C ₈ H ₁₄	0.83
9.935	2-Cyclopenten-1-one, 3,4-dimethyl-	C ₇ H ₁₀ O	0.34
11.033	2-Furancarboxaldehyde, 5-methyl-	C ₆ H ₆ O ₂	5.08
11.292	2-Furancarboxaldehyde, 5-methyl-	C ₆ H ₆ O ₂	0.41
12.023	Phenol	C ₆ H ₆ O	2.26
12.56	Benzofuran	C ₈ H ₆ O	2.25
14.377	Benzene, cyclopropyl-	C ₉ H ₁₀	0.62
14.785	Indene	C ₉ H ₈	0.62
15.438	Phenol, 3-methyl-	C ₇ H ₈ O	1.41
15.87	Acetophenone	C ₈ H ₈ O	0.33
16.604	Phenol, 3-methyl-	C ₇ H ₈ O	1.22
16.74	Phenol, 3-methyl-	C ₇ H ₈ O	0.40
17.611	2H-Inden-2-one, 1,3-dihydro-	C ₉ H ₈ O	0.56
17.863	Benzofuran, 2-methyl-	C ₉ H ₈ O	1.27
19.832	Phenol, 2-methyl-6-(2-propenyl)-	C ₁₀ H ₁₂ O	0.35
20.09	Tetracyclo[5.3.0.0<2,6>.0<3,10>]deca-4,8-diene	C ₁₀ H ₁₀	0.92
21.43	Naphthalene	C ₁₀ H ₈	0.83
21.567	Naphthalene	C ₁₀ H ₈	0.35
22.934	Cinnamaldehyde, β-methyl-	C ₁₀ H ₁₀ O	0.34
25.07	Tetradecane	C ₁₄ H ₃₀	0.39
25.168	Tetradecane	C ₁₄ H ₃₀	1.30
25.753	2H-Inden-2-one, 1,3-dihydro-	C ₉ H ₈ O	1.79
26.529	Naphthalene, 1-methyl-	C ₁₁ H ₁₀	0.86
26.937	Tetradecane	C ₁₄ H ₃₀	0.43
27.189	Naphthalene, 2-methyl-	C ₁₁ H ₁₀	0.66
30.879	1-Tetradecene	C ₁₄ H ₂₈	0.54
31.233	Tetradecane, 2,6,10-trimethyl-	C ₁₇ H ₃₆	0.41
31.831	Pentadecane, 2-methyl-	C ₁₆ H ₃₄	0.33

Table S10

Main identified products from catalytic pyrolysis of PP with Cat-C

RT (min)	Peak Name	Chem. Formula	Relative Area (%)
2.34	Cyclopropane, 1,2,3-trimethyl-	C ₆ H ₁₂	4.74
2.541	2-Pentene, 3-methyl-, (Z)-	C ₆ H ₁₂	8.07
2.803	2-Pentene, 4,4-dimethyl-, (Z)-	C ₇ H ₁₄	3.68
2.894	Benzene	C ₆ H ₆	6.01
3.146	Cyclopentane, 1,3-dimethyl-	C ₇ H ₁₄	1.58
3.296	3-Hexene, 3-methyl-, (Z)-	C ₇ H ₁₄	5.12
3.905	3-Hexene, 3-methyl-, (Z)-	C ₇ H ₁₄	1.01
4.095	3-Octene, (Z)-	C ₈ H ₁₆	3.13
4.387	1,3,5-Cycloheptatriene	C ₇ H ₈	5.73
4.768	3-Octene, (E)-	C ₈ H ₁₆	0.59
4.921	4-Octene, (E)-	C ₈ H ₁₆	0.91
5.146	3-Octene, (Z)-	C ₈ H ₁₆	1.89
5.36	1-Octene	C ₈ H ₁₆	1.17
6.034	2,3-Dimethyl-3-heptene	C ₉ H ₁₈	1.90
6.415	2,2-Dimethyl-3-heptene trans	C ₉ H ₁₈	1.82
6.608	trans--4-Nonene	C ₉ H ₁₈	1.50
6.795	trans--4-Nonene	C ₉ H ₁₈	0.56
6.966	Ethylbenzene	C ₈ H ₁₀	1.21
7.125	1-Dodecene	C ₁₂ H ₂₄	0.79
7.323	Benzene, 1,3-dimethyl-	C ₈ H ₁₀	2.91
7.68	2,2-Dimethyl-3-heptene trans	C ₁₀ H ₂₀	1.02
7.904	1-Dodecene	C ₁₂ H ₂₄	0.51
8.125	o-Xylene	C ₈ H ₁₀	1.49
8.272	2,3-Dimethyl-3-heptene	C ₉ H ₁₈	0.50
8.391	3-Heptene, 2,6-dimethyl-	C ₉ H ₁₈	0.38
9.391	3-Octene, 2,2-dimethyl-	C ₁₀ H ₂₀	0.52
9.928	2-Decene, (Z)-	C ₁₀ H ₂₀	0.63
10.479	2-Decene, (Z)-	C ₁₀ H ₂₀	0.50
10.751	cis-3-Decene	C ₁₀ H ₂₀	0.99
10.965	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	1.55
11.339	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	0.85
11.71	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	0.55
12.462	Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	1.93
12.679	Cyclopentane, 1,2-dipropyl-	C ₁₁ H ₂₂	0.43
12.744	1-Tridecene	C ₁₃ H ₂₆	0.41
13.105	1-Tridecene	C ₁₃ H ₂₆	0.58
13.676	Mesitylene	C ₉ H ₁₂	0.89
14.285	1-Tridecene	C ₁₃ H ₂₆	0.42
15.108	1-Tridecene	C ₁₃ H ₂₆	0.53

15.428	Benzene, 1-methyl-4-(1-methylethyl)-	C ₁₀ H ₁₄	1.09
15.638	1-Tridecene	C ₁₃ H ₂₆	0.56
16.703	p-Cymene	C ₁₀ H ₁₄	0.91
17.407	1-Tridecene	C ₁₃ H ₂₆	0.46
17.567	1-Tridecene	C ₁₃ H ₂₆	0.55
18.216	Benzene, 1-methyl-4-(1-methylethyl)-	C ₁₀ H ₁₄	0.49
18.373	p-Cymene	C ₁₀ H ₁₄	0.52
19.801	Benzene, 1-methyl-4-(1-methylethyl)-	C ₁₀ H ₁₄	0.58
20.002	1-Tridecene	C ₁₃ H ₂₆	0.61
20.07	1-Tridecene	C ₁₃ H ₂₆	0.42
20.267	Benzene, 1-methyl-4-(1-methylethyl)-	C ₁₀ H ₁₄	0.41
21.39	Naphthalene	C ₁₀ H ₈	2.66
22.029	1-Tridecene	C ₁₃ H ₂₆	0.84
25.216	Naphthalene, 1,2-dihydro-3-methyl-	C ₁₁ H ₁₂	1.00
25.75	1-Tridecene	C ₁₃ H ₂₆	1.25
26.512	Benzocycloheptatriene	C ₁₁ H ₁₀	2.46
27.158	Bicyclo[4.4.1]undeca-1,3,5,7,9-pentaene	C ₁₁ H ₁₀	1.05
28.308	2-Piperidinone, N-[4-bromo-n-butyl]-	C ₁₃ H ₂₆	0.42
30.1	tert-Hexadecanethiol	C ₁₃ H ₂₆	0.49
31.807	Naphthalene, 1-(1-methylethyl)-	C ₁₃ H ₁₄	0.76
36.596	Heptadecane	C ₁₇ H ₃₆	0.20

Table S11

All peaks for the catalytic pyrolysis of cellulose or PP with catalyst M and Cat-C

Cellulose with M		PP with M		Cellulose with Cat-C		PP with Cat-C	
RT (min)	Area (%)	RT (min)	Area (%)	RT (min)	Area (%)	RT (min)	Area (%)
2.418	12.55	2.187	7.28	2.483	10.63	2.541	8.07
2.748	0.93	2.503	12.39	2.537	6.47	2.803	3.68
2.884	0.89	2.792	3.58	2.786	2.93	2.894	6.01
3.027	0.37	2.874	3.44	2.928	5.02	3.146	1.58
3.285	1.77	3.132	2.49	3.102	1.99	3.296	5.12
3.544	0.94	3.275	8.49	3.343	5.13	3.905	1.01
3.908	0.06	3.741	0.13	3.595	1.90	4.095	3.13
3.996	0.89	3.891	0.95	4.415	2.80	4.387	5.73
4.367	1.77	4.081	3.38	4.928	0.44	4.768	0.59
4.863	0.10	4.21	2.43	5.112	2.53	4.921	0.91
5.04	11.73	4.445	1.55	5.537	0.55	5.146	1.89
5.472	1.01	4.877	2.95	6.173	17.98	5.36	1.17
6.074	23.08	5.122	3.84	6.275	3.45	5.683	0.14
6.186	1.40	5.333	1.32	6.816	0.42	5.836	0.20
6.748	0.31	5.479	0.38	7.357	0.66	6.034	1.90
6.962	0.11	5.833	0.16	7.741	0.42	6.415	1.82

7.088	1.32	6.023	1.75	8.153	1.07	6.608	1.50
7.302	0.27	6.404	1.72	8.598	2.06	6.795	0.56
7.646	1.19	6.601	2.18	8.809	0.83	6.966	1.21
8.084	0.63	6.802	0.77	9.935	0.34	7.125	0.79
8.52	0.43	6.897	0.77	11.033	5.08	7.323	2.91
8.724	0.77	7.217	1.82	11.292	0.41	7.68	1.02
9.37	0.90	7.336	1.16	12.023	2.26	7.904	0.51
9.598	0.09	7.622	1.53	12.56	2.25	8.125	1.49
9.829	0.28	7.928	1.48	14.377	0.62	8.272	0.50
10.547	0.16	8.112	0.57	14.785	0.62	8.391	0.38
10.717	0.10	8.268	1.14	15.438	1.41	8.666	0.14
10.955	6.33	8.401	0.87	15.87	0.33	8.748	0.12
11.217	0.23	8.68	0.60	16.604	1.22	9.03	0.29
11.479	0.06	8.965	0.32	16.74	0.40	9.176	0.22
11.717	0.06	9.047	0.25	17.611	0.56	9.391	0.52
11.877	1.48	9.196	0.25	17.863	1.27	9.928	0.63
12.496	1.30	9.424	0.22	19.832	0.35	10.299	0.24
12.7	0.34	9.503	0.14	20.09	0.92	10.479	0.50
13.081	0.08	9.928	0.91	21.43	0.83	10.751	0.99
13.441	0.17	10.332	0.30	21.567	0.35	10.965	1.55
13.669	0.11	10.479	0.80	22.934	0.34	11.224	0.00
13.849	0.47	10.768	0.84	25.07	0.39	11.339	0.85
14.131	0.08	10.856	0.28	25.168	1.30	11.611	0.30
14.291	0.36	10.982	0.29	25.753	1.79	11.71	0.55
14.465	0.13	11.071	0.90	26.529	0.86	12.05	0.37
14.73	0.87	11.377	0.69	26.937	0.43	12.462	1.93
14.853	0.19	11.638	0.66	27.189	0.66	12.679	0.43
14.948	0.21	11.737	0.19	30.879	0.54	12.744	0.41
15.203	0.09	11.962	0.12	31.233	0.41	13.105	0.58
15.281	0.43	12.091	0.84	31.831	0.33	13.455	0.34
15.791	0.25	12.468	1.11			13.676	0.89
16.363	0.42	12.713	0.69			13.914	0.24
16.556	0.43	13.053	0.17			14.285	0.42
16.693	0.12	13.135	0.39			14.71	0.34
17.257	0.26	13.37	0.12			14.948	0.36
17.601	0.37	13.509	0.32			15.108	0.53
17.801	0.71	13.696	0.43			15.251	0.25
18.016	0.12	13.982	0.24			15.428	1.09
18.985	0.17	14.332	0.42			15.638	0.56
19.254	0.10	14.461	0.16			15.768	0.24
19.668	0.19	14.642	0.13			15.893	0.12
19.771	0.27	14.723	0.26			15.948	0.11
19.924	0.06	14.934	0.60			16.288	0.27
20.032	0.34	15.142	0.63			16.407	0.45

20.25	0.08	15.301	0.26	16.703	0.91
21.121	0.21	15.407	0.32	16.842	0.18
21.366	0.12	15.472	0.19	17.281	0.21
21.491	1.30	15.54	0.19	17.407	0.46
21.923	0.18	15.638	0.53	17.567	0.55
22.328	0.08	15.815	0.25	17.699	0.38
22.457	0.13	15.944	0.41	17.822	0.25
22.723	0.09	16.247	0.15	18.111	0.14
22.869	0.15	16.505	0.27	18.216	0.49
23.019	0.06	16.74	0.37	18.373	0.52
23.11	0.09	16.89	0.13	18.506	0.17
23.267	0.18	17.107	0.17	19.278	0.12
23.515	0.11	17.244	0.31	19.437	0.19
24.161	0.08	17.454	0.49	19.573	0.16
24.42	0.08	17.618	0.18	19.682	0.36
24.913	0.12	17.743	0.36	19.801	0.58
25.137	0.14	17.873	0.18	20.002	0.61
25.192	0.09	18.243	0.28	20.07	0.42
25.478	0.18	18.407	0.23	20.267	0.41
25.637	0.37	18.665	0.15	20.478	0.14
26.41	0.36	19.036	0.12	20.611	0.23
26.852	0.18	19.206	0.16	20.941	0.16
27.052	0.58	19.359	0.18	21.39	2.66
27.369	0.40	19.539	0.12	21.686	0.37
27.579	0.09	19.652	0.19	22.029	0.84
28.005	0.19	19.845	0.44	23.291	0.33
29.093	0.26	20.036	0.24	23.736	0.15
30.549	0.38	20.148	0.16	23.808	0.17
30.936	0.21	20.209	0.17	24.733	0.26
31.164	0.19	20.332	0.13	24.866	0.35
31.351	0.10	20.43	0.18	25.216	1.00
31.691	0.25	20.648	0.15	25.495	0.16
32.174	0.48	20.995	0.13	25.75	1.25
33.97	0.75	21.658	0.13	26.195	0.29
34.957	0.24	21.957	0.29	26.512	2.46
35.263	0.15	22.134	0.16	26.852	0.26
35.433	0.06	23.335	0.12	27.158	1.05
35.616	0.23	23.801	0.14	27.464	0.24
35.848	0.49	24.185	0.11	27.627	0.18
37.467	0.13	24.855	0.14	27.791	0.27
38.177	0.23	25.369	0.15	28.308	0.42
38.854	0.24	25.542	0.17	29.042	0.12
38.946	0.13	25.753	0.28	29.654	0.15
39.946	0.16	25.94	0.15	29.882	0.36

40.157	0.08	26.209	0.19	30.1	0.49
42.572	0.23	26.457	0.20	30.77	0.22
42.844	0.31	26.889	0.11	30.845	0.18
46.112	0.34	27.253	0.17	31.236	0.25
		39.235	0.11	31.671	0.11
				31.807	0.76
				32.045	0.15
				32.59	0.34
				33.226	0.26
				33.76	0.19
				34.77	0.33
				35.293	0.20
				36.596	0.20
