Electronic Supplementary Material (ESI) for Catalysis Science & Technology.

Supplementary information

Development of a catalytically green route from diverse lignocellulosic biomasses to high-density cycloalkanes for jet fuels

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Table S1 Proximate and elemental analyses of diverse lignocellulosic biomasses

Characteristics	Hybrid poplar sawdust	Loblolly pine sawdust	Douglas fir sawdust pellets
Proximate analysis (wt%)			
Moisture	5.34	5.50	4.82
Volatile matter	75.87	78.23	76.08
Fixed carbon	17.36	15.74	18.89
Ash	1.43	0.53	0.21
Elemental analysis (wt%)			
Carbon	50.20	49.30	47.90
Hydrogen	6.02	6.02	6.55
Nitrogen	0.59	0.06	0.08
Oxygen[a]	43.19	44.62	45.57

[a]by difference

Table S2 Experimental design and product yield distribution of hybrid poplar

Run[a]	Catalytic Temperature (ºC)	Catalyst to biomass ratio	Yield (wt.%)			
			Organics	Gas	Char	Coke
H-1	300	0.15	18.65	40.54	22.59	2.68
H-2	300	0.35	17.38	42.87	22.22	3.23
H-3	450	0.15	15.65	48.84	21.52	1.27
H-4	450	0.35	14.44	50.34	22.88	2.25
H-5	269	0.25	19.21	42.22	22.59	3.57
H-6	375	0.25	17.20	44.82	22.54	2.00
H-7	375	0.25	17.43	45.01	23.17	2.03
H-8	375	0.25	17.53	45.21	22.34	2.12
H-9	375	0.25	17.11	44.76	22.56	1.98
H-10	375	0.25	17.33	44.88	21.89	2.23
H-11	481	0.25	15.46	48.74	21.98	1.54
H-12	375	0.11	18.23	43.21	22.20	1.89
H-13	375	0.39	16.21	46.02	22.91	2.43
H-14	500	0.25	14.87	50.05	23.01	1.27
H-15	375	0.50	15.89	47.23	22.63	2.98
H-16	-	-	22.07	39.20	22.52	-

[a] H-1 to H-13 was conducted based on central composite design; H-14 and H-15 were added as the controls; H-16 is the control in the absence of catalyst.

Table S3 Experimental design and product yield distribution of loblolly pine

Run[a]	Catalytic Temperature (ºC)	Catalyst to biomass ratio	Yield (wt.%)			
			Organics	Gas	Char	Coke
L-1	300	0.15	17.78	41.38	20.20	2.25
L-2	300	0.35	16.99	44.02	20.11	3.99
L-3	450	0.15	15.01	47.54	20.10	1.18
L-4	450	0.35	13.56	52.02	19.98	1.93
L-5	269	0.25	18.23	42.22	19.65	3.23
L-6	375	0.25	16.67	46.23	19.88	2.44
L-7	375	0.25	16.74	47.02	20.22	2.45
L-8	375	0.25	16.23	46.37	20.34	2.66
L-9	375	0.25	17.05	46.43	19.55	2.22
L-10	375	0.25	16.22	46.82	19.43	2.54
L-11	481	0.25	14.23	50.12	20.22	1.54
L-12	375	0.11	17.43	44.45	20.45	1.74
L-13	375	0.39	16.00	47.82	20.24	2.72
L-14	500	0.25	13.89	52.13	20.53	1.25
L-15	375	0.50	16.01	49.45	19.79	3.04
L-16	-	-	21.02	40.98	19.34	-

[a] L-1 to L-13 was conducted based on central composite design; L-14 and L-15 were added as the controls; L-16 is the control in the absence of catalyst.

Table S4 Experimental design and product yield distribution of Douglas fir

Run[a]	Catalytic Temperature (ºC)	Catalyst to biomass ratio	Yield (wt.%)			
			Organics	Gas	Char	Coke
D-1	300	0.15	17.88	39.45	22.25	3.03
D-2	300	0.35	17.11	40.25	21.50	3.98
D-3	450	0.15	15.48	46.20	21.85	2.02
D-4	450	0.35	13.88	49.66	21.63	2.65
D-5	269	0.25	18.67	40.20	21.78	4.02
D-6	375	0.25	16.88	44.02	22.54	2.82
D-7	375	0.25	16.77	44.34	22.78	2.94
D-8	375	0.25	16.96	44.21	22.07	2.78
D-9	375	0.25	16.54	44.02	21.74	3.02
D-10	375	0.25	16.82	44.01	21.56	2.98
D-11	481	0.25	14.65	47.89	22.21	2.44
D-12	375	0.11	18.00	42.88	21.85	2.71
D-13	375	0.39	15.99	44.23	21.90	3.55
D-14	500	0.25	14.02	49.11	22.05	1.95
D-15	375	0.50	16.32	45.56	22.12	3.90
D-16	-	-	20.88	38.18	21.25	-

[a] D-1 to D-13 was conducted based on central composite design; D-14 and D-15 were added as the controls; D-16 is the control in the absence of catalyst.

Table S5 Proportion of cellulose, hemicellulose and lignin (as% dry weight) in various biomass species

	Hybrid poplar sawdust	Loblolly pine sawdust	Douglas fir sawdust pellets
Cellulose	49	42	44
Hemicellulose	22	21	21
Lignin	23	26	32

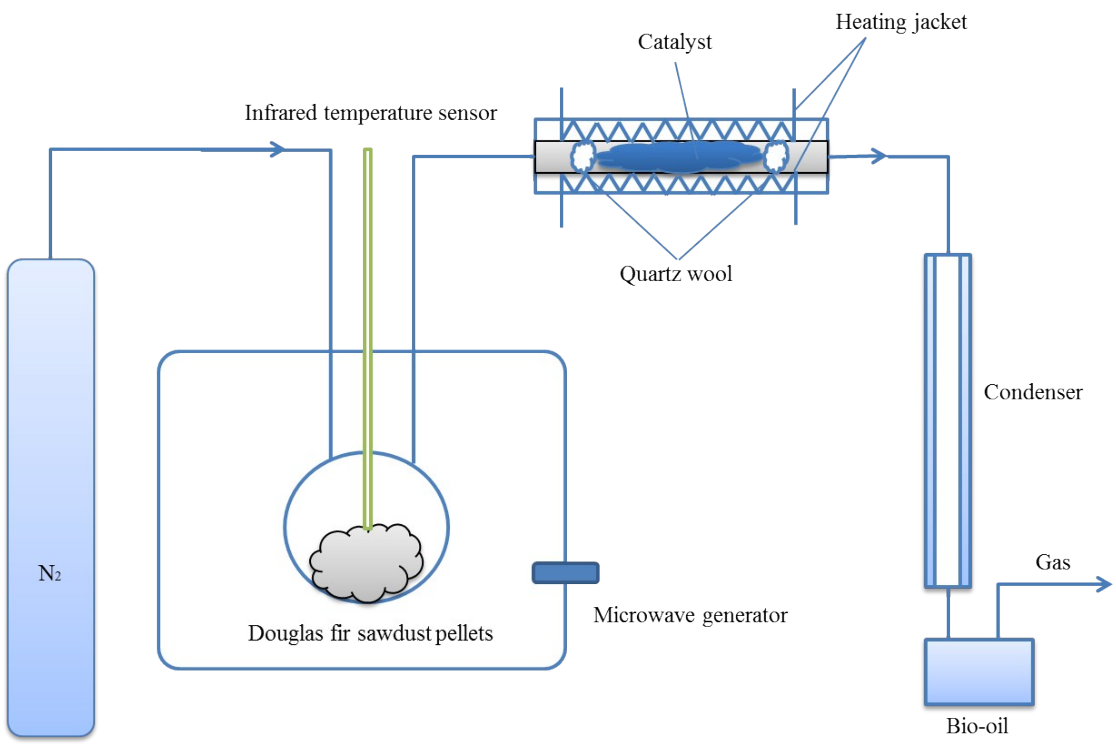

Fig. S1 The schematic diagram of the microwave-assisted pyrolysis system integrated with catalysis process

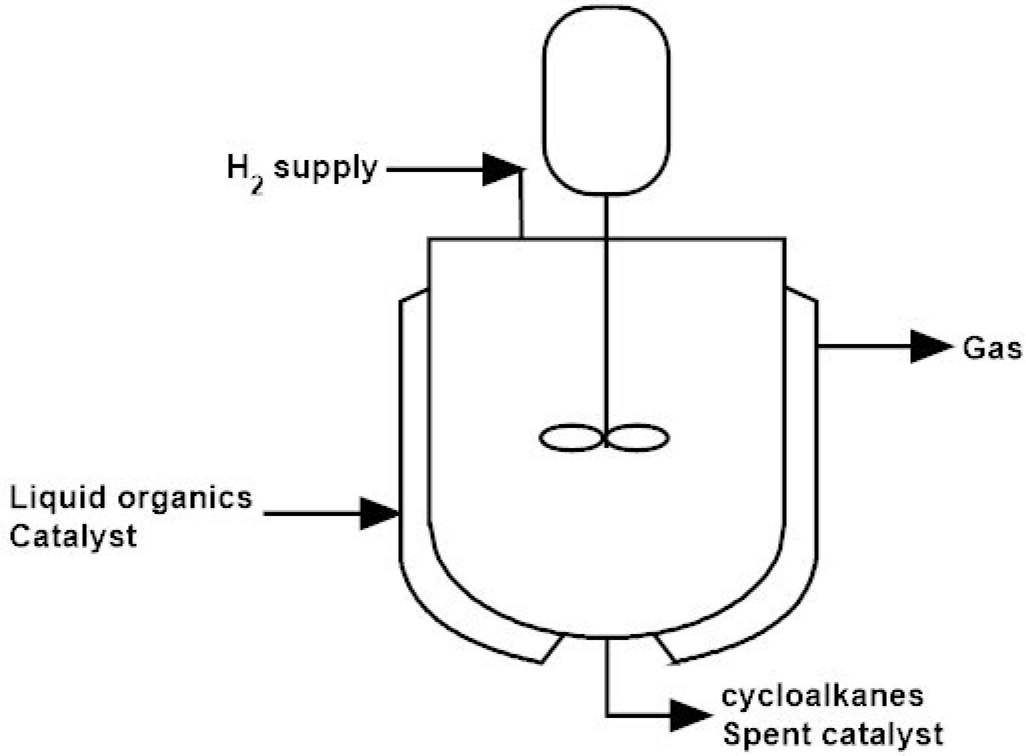

Fig. S2 The schematic overview of the hydrogenation process set-up

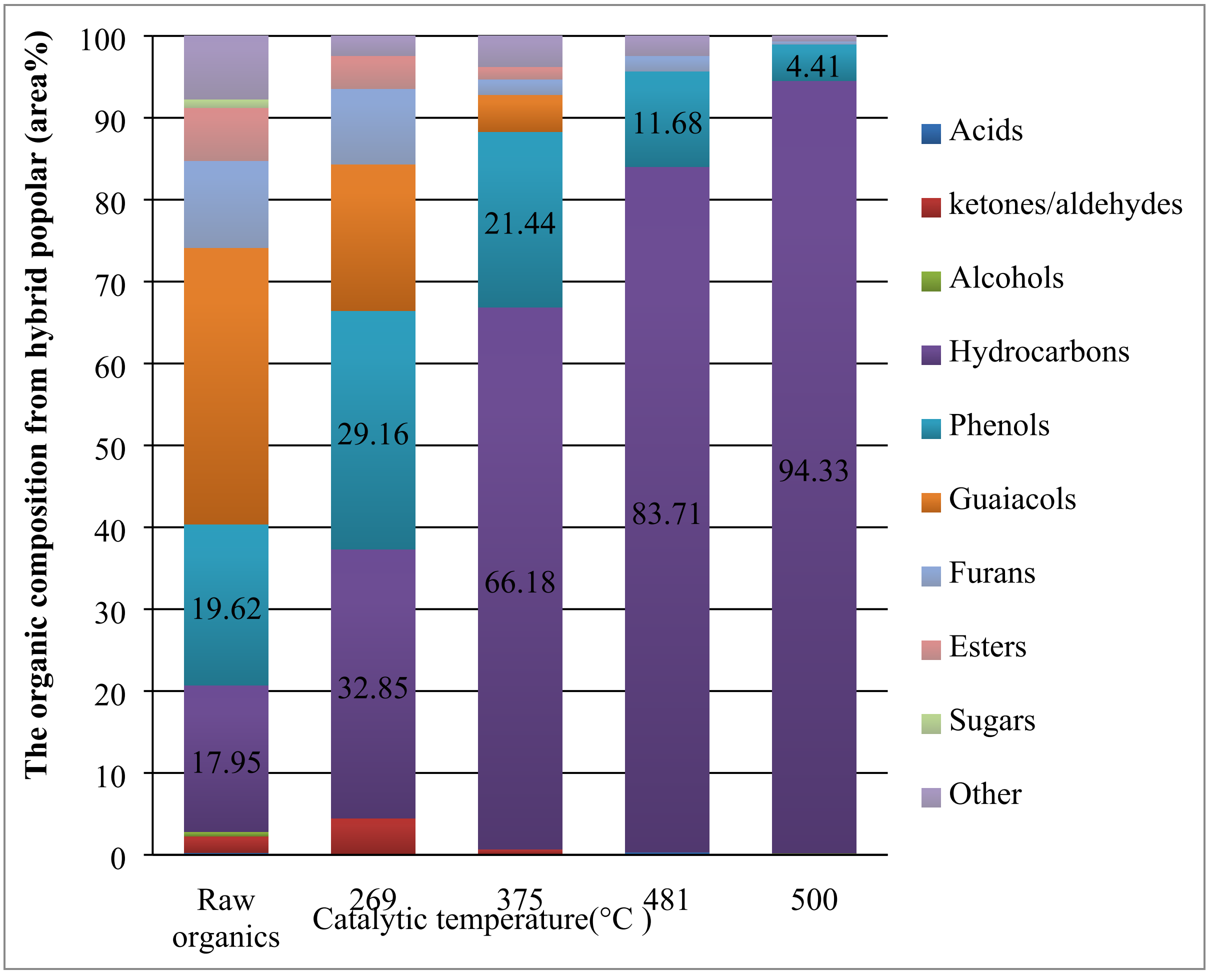

Fig. S3 The organic compositon from hybrid poplar as a function of catalytic temperature at the same biomass to catalyst ratio (0.25).

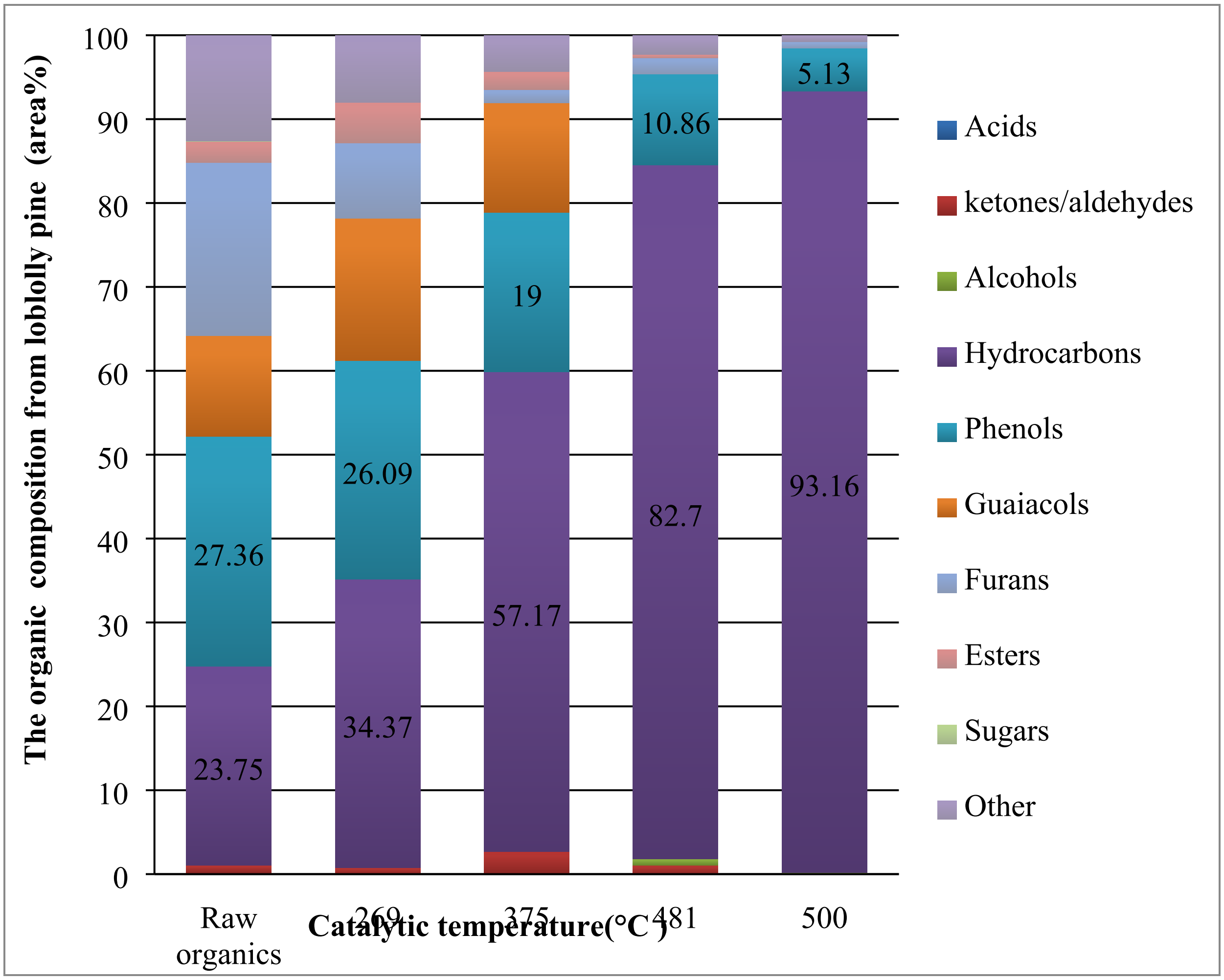

Fig. S4 The organic compositon from loblolly pine as a function of catalytic temperature at the same biomass to catalyst ratio (0.25).

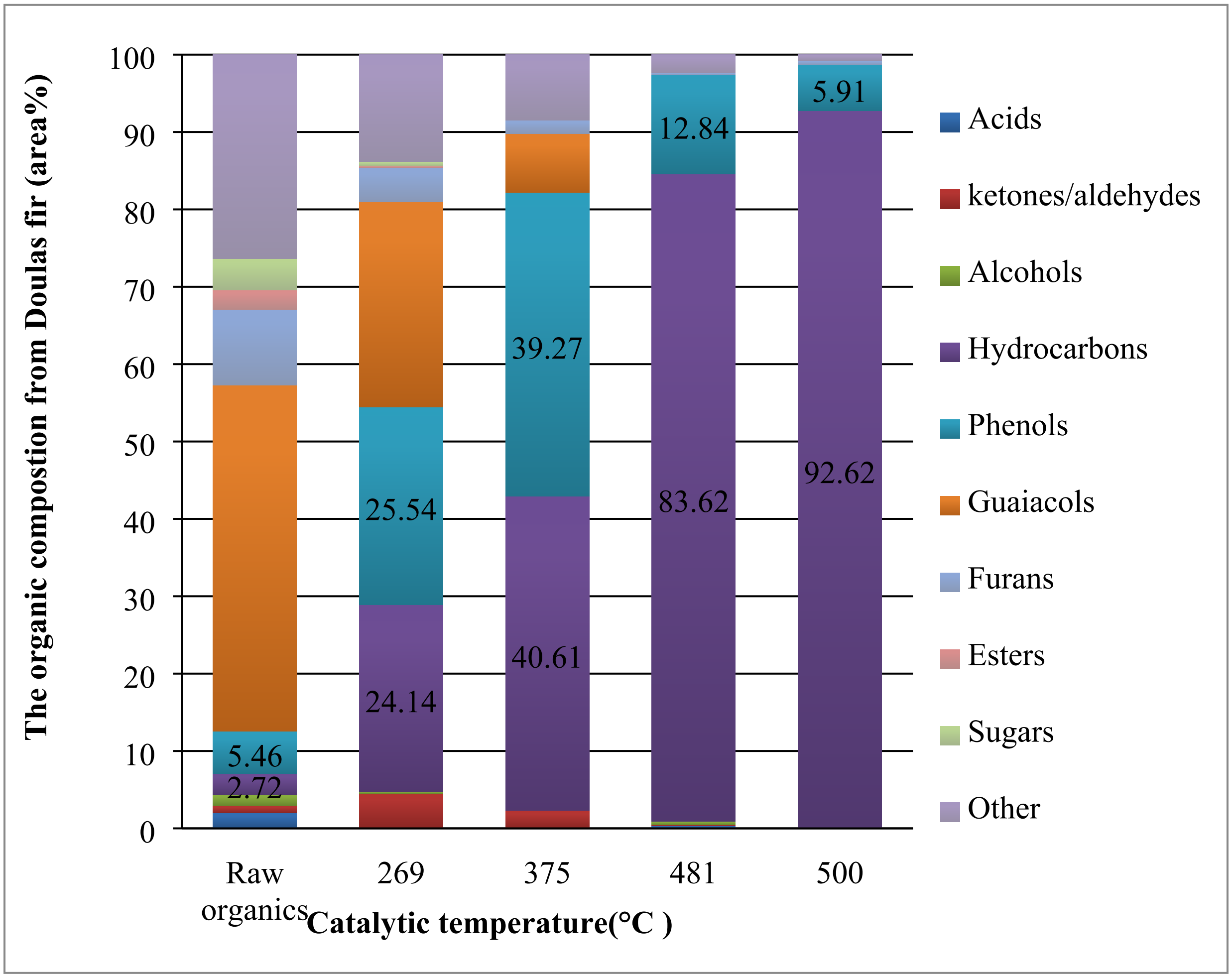

Fig. S5 The organic compositon from Douglas fir as a function of catalytic temperature at the same biomass to catalyst ratio (0.25).