

Influence of biomass inorganics on the functionality of H⁺ZSM-5 catalyst during in-situ catalytic fast pyrolysis

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SUPPLEMENTARY INFORMATION:

Table S1. List of compounds quantified from in-situ CFP experiments

Aromatic Hydrocarbons	Phenols	Guaiacols	Furans
Benzene	Phenol	Phenol, 2-methoxy	Furan, 2-methyl
Toluene	Phenol, 2-methyl	Phenol, 2-methoxy-4-methyl	Furan, 2,5 dimethyl
Xylene	Phenol, 4-methyl	Phenol, 4-ethyl 2-methoxy	Furfural
Ethyl benzene	Phenol, 2,4-dimethyl	Eugenol	2(5H)-Furanone
Benzene, 1-ethyl-2-methyl-	Phenol, 3,5 dimethyl	Phenol, 2-methoxy 4-vinyl	Furan, 2-ethyl-5-methyl
Trimethyl Benzene	Phenol, 3-ethyl	Vanillin	2-Furancarboxaldehyde, 5-methyl
Naphthalene	Phenol, 4-ethyl	Ketones	
Naphthalene, 1-methyl		2-Cyclopenten-1-one,2-methyl	
Naphthalene, 2,6 dimethyl		2-Cyclopenten-1-one,3-methyl	
Naphthalene, 2-methyl		2-Cyclopenten-1-one,2,3dimethyl	
Phenanthrene			
Fluorene			
Anthracene			

Table S2. Detailed product distributions from *in-situ* catalytic pyrolysis of biomass and H⁺ZSM-5 catalyst doped with various amounts of Ca.

Component	Overall Carbon Yield (C %)									
	Control	Std. dev	Ca 0.5	Std. dev	Ca 1.0	Std. dev	Ca 2.0	Std. dev	Ca 5.0	Std. dev
Aromatic hydrocarbons	22.35	0.35	22.90	0.28	20.79	0.20	15.44	0.37	9.85	0.35
Phenols	0.06	0.04	0.09	0.03	0.12	0.02	0.64	0.06	1.44	0.11
Guaiacols	0.00	0.00	0.05	0.02	0.13	0.03	0.89	0.14	1.77	0.08
Furans	0.00	0.00	0.12	0.04	0.40	0.12	1.57	0.11	2.89	0.02
Ketones	0.04	0.06	0.04	0.05	0.12	0.04	0.40	0.06	0.86	0.04
Oxygenated compounds	0.10	0.02	0.29	0.01	0.76	0.09	3.50	0.15	6.95	0.25
Total carbon yield	22.45	0.37	23.19	0.27	21.55	0.29	18.94	0.52	16.80	0.60

Table S3. Detailed product distributions from *in-situ* catalytic pyrolysis of biomass H⁺ZSM-5 catalyst doped with various amounts of K.

Component	Overall Carbon Yield (C %)									
	Control	Std. dev	K 0.5	Std. dev	K 1.0	Std. dev	K 2.0	Std. dev	K 5.0	Std. dev
Aromatic hydrocarbons	22.35	0.35	13.09	0.33	4.91	0.27	1.43	0.31	0.11	0.04
Phenols	0.06	0.04	0.48	0.06	1.95	0.06	2.27	0.18	2.57	0.19
Guaiaacols	0	0	0.52	0.04	2.08	0.10	2.94	0.10	3.10	0.15
Furans	0	0	0.97	0.09	1.66	0.17	3.60	0.26	4.33	0.24
Ketones	0.04	0.06	0.04	0.05	0.38	0.05	0.63	0.05	0.60	0.16
Oxygenated compounds	0.1	0.02	2.00	0.12	6.07	0.26	9.43	0.59	10.59	0.44
Total carbon yield	22.45	0.37	15.08	0.21	10.98	0.53	10.86	0.28	10.70	0.40

Table S4. Detailed product distributions from *in-situ* catalytic pyrolysis of biomass and H⁺ZSM-5 catalyst doped with various amounts of Na.

Component	Overall Carbon Yield (C %)									
	Control	Std. dev	Na 0.5	Std. dev	Na 1.0	Std. dev	Na 2.0	Std. dev	Na 5.0	Std. dev
Aromatic hydrocarbons	22.35	0.35	14.96	0.11	5.52	0.29	2.12	0.23	0.20	0.06
Phenols	0.06	0.04	0.28	0.05	1.91	0.01	2.13	0.09	2.50	0.27
Guaiaacols	0	0	0.64	0.06	1.99	0.08	2.75	0.04	3.25	0.09
Furans	0	0	1.10	0.03	1.42	0.11	3.25	0.09	4.09	0.11
Ketones	0.04	0.06	0.00	0.00	0.29	0.03	0.63	0.05	0.77	0.08
Oxygenated compounds	0.1	0.02	2.02	0.08	5.61	0.18	8.74	0.27	10.61	0.21
Total carbon yield	22.45	0.37	16.98	0.04	11.12	0.11	10.86	0.04	10.81	0.15