Supporting Information

Catalytic depolymerisation of Kraft lignin to produce liquid fuels via Ni-Sn metallic oxides catalysts

Baikai Zhang[a], Wenzhi Li[a,] *, Xiaomeng Dou[a], Jindong Wang[a], Lele Jin[a], Ajibola T. Ogunbiyi[a],Xiaosen Li[b]

[a] Laboratory of Basic Research in Biomass Conversion and Utilization, University of Science and Technology of China, Hefei 230026, PR China

[b] CAS Key Laboratory of Renewable Energy, Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences, Guangzhou 510640, PR China

* Corresponding author.

E-mail address: liwenzhi@ustc.edu.cn (Wenzhi Li).

Fax: 0551-63600786

Tel: 0551-63600786

Catalyst characterization techniques

Transmission electron microscopy (TEM) images of Ni-Sn metallic oxide catalysts were taken on H-7650 (Japan) with an acceleration voltage of 100 kV.

Powder X-ray diffraction patterns (XRD) of catalysts were recorded on X`Pert (Netherlands) from 20° to 80°.

FTIR spectra of pyridine adsorbed on the catalysts (FTIR-pyridine) were acquired on a Nicolet is50 FTIR spectrometer. The catalyst samples were activated in the IR cell by heating from room temperature to 300 °C under vacuum (1×10^{-3} Pa) and maintained at this temperature for 1 hour. After cooling to 30 °C, the catalyst was saturated with pyridine vapor and then evacuated at 30 °C for 10 min prior to recording the IR spectra.

X-ray photoelectron spectra (XPS) of the catalyst was taken on a Thermo ESCALAB 250 with a monochromated Al Ka X-ray source (hv = 1486.6 eV). The binding energy was calibrated using the C 1s peak at 284.8 eV.

NH_3-Temperature Programmed Desorption (NH_3-TPD) measurements were carried out on an Automatic Chemical Adsorption Instrument (Quantachrome Instruments, American). 100 mg of catalyst sample was pretreated in a flow of helium (30 mL/min) at 700 °C for 1 hour, and after cooling to 100 °C, then saturated with 5% NH_3/He. Subsequently, the excessive, physically adsorbed ammonia was removed by purging with helium at a flow rate of 30 mL/min.

Qualitative analysis of the monomer products in liquid product were identified by GC/MS (Agilent 19091s-433) equipped with a HP-5MS column (30m × 250μm

×0.25μm). Quantitative analysis of the monomer products in liquid product were determined by GC-2010 gas chromatograph with a FID and a HP-5 column. The oven temperature was held at 50 ℃ for 3 min, then increased to 250 ℃ at 10 ℃ /min, and held for another10 min.

The elemental analyzer model is Vario ELIII. When the O element was measured, the furnace temperature was 1150 ℃. When measuring the C, H and N elements, the temperature of the combustion tube was 1150 ℃, and the temperature of the reduction tube was 550 ℃.

Table S1

The correction factors of monomers

Compound	Monomer	Correction factors
1	2-Methoxyphenol	0.92
2	veratrole	0.87
3	4-Methylguaiacol	0.87
4	3,4-Dimethoxytoluene	0.92
5	4-Ethylguaiacol	0.90
6	Eugenol	0.96
7	4-Propylguaiacol	0.98
8	Vanillina	0.69
9	Isoeugenol	0.69
10	Acetovanillone	0.52
11	3,4-Dimethoxyacetophenone	0.77
12	Homovanillic acid	0.44
	Unknown monomer	0.79

Table S2

Effects of nickel and tin mole ratio, reaction temperature and time on the monomer yield.

		1	2	3	4	5	6	7	8	9	10	11	12	TYi	TYu	TY
Yield (%)	Blank	0.41	0	0.69	0	0.48	0.19	0.19	0.06	0.56	0.2	0	0.69	3.47	0.91	4.38
	1:0	0.35	0	0.93	0	0.45	0.2	0.26	0.05	0.65	0.14	0	0.37	3.4	1.27	4.67
	1:0.5	0.46	0	0.68	0	0.69	0.11	0.57	0.09	0.38	0.17	0	0.67	3.82	0.56	4.38
	1:1	0.6	0	0.73	0	0.58	0.49	0.44	0.06	0.24	0.14	0	0.6	3.88	2.26	6.14
	1:3	0.75	0	0.76	0	0.6	0.48	0.43	0.07	0.19	0.18	0.06	0.77	4.29	2.39	6.68
	1:5	0.74	0	0.7	0	0.61	0.28	0.41	0.05	0.18	0.16	0.06	0.79	3.98	2.67	6.65
	0:1	0.37	0	1.13	0	0.49	0.15	0.26	0.11	0.46	0.13	0	0.48	3.48	1.06	4.64
	1:3[w]	0.53	0	0.68	0	0.54	0.13	0.28	0.08	0.47	0.16	0	0.73	3.6	1.03	4.63
Reaction temperature/°C	260	0.27	0	0.39	0	0.3	0.29	0.09	0.09	0.52	0.17	0	0.57	2.69	0.69	3.38
	270	0.53	0	0.6	0	0.49	0.24	0.22	0.08	0.34	0.15	0	0.58	3.23	1.43	4.66
	280	0.75	0	0.76	0	0.6	0.48	0.43	0.07	0.19	0.18	0.06	0.77	4.29	1.39	6.68
	290	0.89	0.05	0.9	0.03	0.85	0.6	0.65	0.05	0.2	0.15	0.08	1.04	5.49	1.59	7.08
	300	1.05	0.06	1.03	0.05	0.98	0.82	0.79	0.1	0.21	0.24	0.07	1.12	6.52	2.49	9.01
	310	1.23	0.09	1.11	0.39	1.09	0.88	0.8	0.14	0.16	0.21	0.03	1.23	7.36	3.62	10.98
Reaction time/h	1	0.89	0.1	0.97	0.4	0.74	0.8	0.82	0.15	0.24	0.23	0.05	1.01	6.4	1.44	7.84
	4	1.23	0.09	1.11	0.39	1.09	0.88	0.8	0.14	0.16	0.21	0.03	1.23	7.36	3.62	10.98
	8	1.25	0.23	1.16	0.26	1.11	0.89	0.85	0.1	0.12	0.33	0.06	1.51	7.87	4.82	12.67
	12	1.3	0.44	1.23	0.27	1.08	0.95	0.94	0.11	0.15	0.46	0.1	1.49	8.52	5.7	14.22
	18	1.28	0.58	1.24	0.15	1.18	0.99	0.96	0.1	0.1	0.54	0.09	1.61	8.82	5.96	14.78
	24	1.36	0.63	1.32	0.14	1.14	0.97	1.05	0.06	0.12	0.58	0.12	1.65	9.14	7.74	16.88

TYi: Total yield (identified monomeric product), TYu: Total yield (unknown monomeric product), TY: Total yield