참나무, 소나무 리그닌 저분자화

24. 07. 03. (수)

1. 실험 디자인

■ 참나무, 소나무 오가노솔브 펄핑 (리그닌 추출) - 매주 수요일 2번씩

no.	바이오매스		리그닌	날짜(7L 번씩)									
1	참나무 **(껍질o)**	63.5kg	800~1000g	① 3/4 월	④ 3/6 수	⑤ 3/1 3 수	⑥ 3/1 3 수	⑦ 3/18 월	⑧ 3/20 수	⑨ 3/20 수	⑫ 4/1 월	⑮ 4/24 수	⑭ 4/24 수
2	참나무 (껍질x)	40.8kg	160~200g	② 3/5 화	⑩ 3/27 수								
3	소나무 **(껍질o)**	3.7kg	160~200g + 46g	⑬ 4/17 수	⑭ 4/17 수								
4	소나무 (껍질x)	32.4kg	160~200g	③ 3/6 수	⑪ 3/27 수								

■ 참나무(껍질O) 리그닌 - 촉매, 온도별 조건 실험

▶ 리그닌 : 8g (고액비 1:10)
▶ 용매 : 글리세롤 10%

no.	용매	시간	온도	촉매	날짜 1cycle	날짜 2cycle	재실험
1	글리세롤 10%	30 min	250℃	X	3/11(월)	3/20(수)	오차범위 5%이상 4/8(월) 4/9(화) 4/10(수) 4/11(목)
2			300℃		3/11(월)	3/20(수)	
3			350℃		3/12(화)	3/21(목)	
13			400℃		4/1(월)	4/3(수)	
4			250℃	Pt/C	3/12(화)	3/21(목)	
5			300℃		3/13(수)	3/25(월)	
6			350℃		3/13(수)	3/25(월)	
14			400℃		4/1(월)	4/3(수)	
7			250℃	Ru/C	3/14(목)	3/26(화)	
8			300℃		3/14(목)	3/26(화)	
9			350℃		3/18(월)	3/27(수)	
15			400℃		4/2(화)	4/4(목)	
10			250℃	Raney Ni	3/18(월)	3/27(수)	
11			300℃		3/19(화)	3/28(목)	
12			350℃		3/19(화)	3/28(목)	
16			400℃		4/2(화)	4/4(목)	

▶ 리그닌 : 8g (고액비 1:10)
▶ 용매 : 글리세롤 10%

no.	리그닌	용매	시간	온도	촉매	날짜 1cycle	날짜 2cycle	재실험
1	참나무 (껍질X)	글리세롤 10%	30 min	250℃	Ru/C	5/14(화)	5/27(월)	오차범위 5%이상 6/5(수) 6/9(금)
2				300℃		5/14(화)	5/27(월)	
3				350℃		5/16(목)	5/28(화)	
4				400℃		5/16(목)	5/28(화)	
5	소나무 (껍질O)			250℃		5/20(월)	5/29(수)	
6				300℃		5/20(월)	5/29(수)	
7				350℃		5/21(화)	5/30(목)	
8				400℃		5/22(수)	5/30(목)	
9	소나무 (껍질X)			250℃		5/22(수)	6/3(월)	
10				300℃		5/23(목)	6/3(월)	
11				350℃		5/23(목)	6/4(화)	
12				400℃		5/24(금)	6/4(화)	

■ 참나무(껍질O) 리그닌 - 글리세롤 0%, 온도별 조건 실험

▶ 리그닌 : 8g (고액비1:10)
▶ 용매 : 글리세롤 0%

no.	리그닌	용매	시간	온도	촉매	날짜 1cycle	날짜 2cycle	재실험
1	참나무 (껍질O)	글리세롤 0%	30 min	250℃	X	6/13(목)	6/18(화)	오차범위 5%이상 6/20(목) 6/21(금)
2				300℃		6/13(목)	6/18(화)	
3				350℃		6/14(금)	6/19(수)	
4				400℃		6/17(월)	6/19(수)	

2. 분석

분석	샘플	분석	샘플
GC (가스_수소)	반응 후 가스	고체분석	바이오매스 5종
GC-MS (Scan_정성)	lignin 5종		lignin 5종
	1번 Bio-oil 16개	EA	lignin 5종
			Bio-oil 32개
	2,3번 Bio-oil 16개	FTIR	lignin 5종
GC-MS (Sim_정량)	lignin 5종		Bio-oil 32개
	Bio-oil 32개	TGA	lignin 5종
NMR 31P	lignin 5종		Bio-oil 32개
	Bio-oil 32개	FT-ICR (외부 분석)	

3월	20일(수)	HPLC 스탠다드	
	26일(화)	고체분석 준비(도가니 소성 및 황산 72%)	
	27일(수)	HPLC 표준물질 데이터 점검	
		고체 분석	
4월	3~5일(수~금)	NMR 공실관 예약 / 31P NMR	
	8~12일(월~금)	GC-MS 정성 16개	
	16일(화)	고체분석 준비(도가니 소성 및 황산 72%)	
	17일(수)	고체 분석	
5월	8~10(수~금)	GC-MS 정성 4개	
	1, 8, 22, 29, 6/5 (수)	TGA	TGA, EA, FTIR 각각 맡아서 분석 마무리
	1, 8, 22, 29, 6/5 (수)	FTIR	
	8, 22, 29, 6/5 (수)	EA 공실관 예약	
6월	6/3~5 (월~수)	GC-MS 정성 12개	
	6/7~14 (금~금)	GC-MS 정량 : 표준물질 분석, 시료 4+32개	
	6/7~14 (금~금)	NMR 31P 25개	

3. 전체 일정

		3월	4월	5월	6월
리그닌 펄핑		4, 18(월) / 5(화) / 6, 13, 20, 27일(수)	17, 24일(수)		
저분자화 실험		3/11~4/11 참나무(O) 촉매, 온도별 16조건			
				5/14~6/4 리그닌별 12조건	6/13~6/21 글리세롤 0% 4조건
분석	GC (가스_수소)	3/11~4/11		5/14~6/4	
	GC-MS (Scan_정성)		4/8~12일 촉매, 온도별 16조건		6/3~5일 리그닌별 12조건
	GC-MS (Sim_정량)				6/7~14일 lignin 5종, Bio-oil 28개
	NMR 31P		**4/3(수)**~5일 리그닌 4종		6/7~14일 Bio-oil 32개
	고체분석	3/20, 27일(수)	4/17일 (수)		
	EA, FTIR, TGA			5/1, 8, 22, 29일 6/5일 (수)	

4. 실험 결과

■ 고체분석

1.

Biomass	Carbohydrates					Lignin		Ash
	Glucan	Xylan	Mannan	Galactan	Arabinan	AIL	ASL	
참나무(껍질 O)	23.11	11.58			0.62	28.34		1.12
참나무(껍질 X)	24.73	10.84			0.70	24.43		1.25
소나무(껍질 O)	25.10	19.43			0.62	29.97		1.36
소나무(껍질 X)	25.85	19.69			0.46	29.46		1.41
케나프	22.38	12.34			0.54	19.87		1.53

Lignin	Pulp yield (%dw)a	Lignin yield (%)b	Chemical composition					
			AIL	ASL	Glucan	XMG	Arabinan	Ash
참나무(껍질 O)			91.31		5.42	8.86	0.32	1.48
참나무(껍질 X)			87.75		5.02	12.16	0.51	1.05
소나무(껍질 O)			93.25		4.94	10.66	0.38	1.36
소나무(껍질 X)			88.79		4.68	9.72	0.54	1.60
케나프			90.31		4.51	5.35	0.48	1.67

2.

Biomass	Lignin						Ash		
	AIL			ASL					
참나무(껍질 O)	29.86	±	1.52		±		1.21	±	0.09
참나무(껍질 X)	25.36	±	0.92		±		1.16	±	0.09
소나무(껍질 O)	31.04	±	1.07		±		1.18	±	0.18
소나무(껍질 X)	30.28	±	0.82		±		0.93	±	0.48
케나프	20.33	±	0.458		±		1.07	±	0.46

Biomass	Chemical composition					
	AIL			Ash		
참나무(껍질 O)	90.22	±	1.09	0.72	±	0.76
참나무(껍질 X)	86.39	±	1.36	0.60	±	0.45
소나무(껍질 O)	93.82	±	0.58	0.72	±	0.64
소나무(껍질 X)	87.79	±	0.99	0.93	±	0.67
케나프	90.70	±	0.40	1.06	±	0.61

■ 참나무, 소나무 오가노솔브 펄핑 (리그닌 추출)

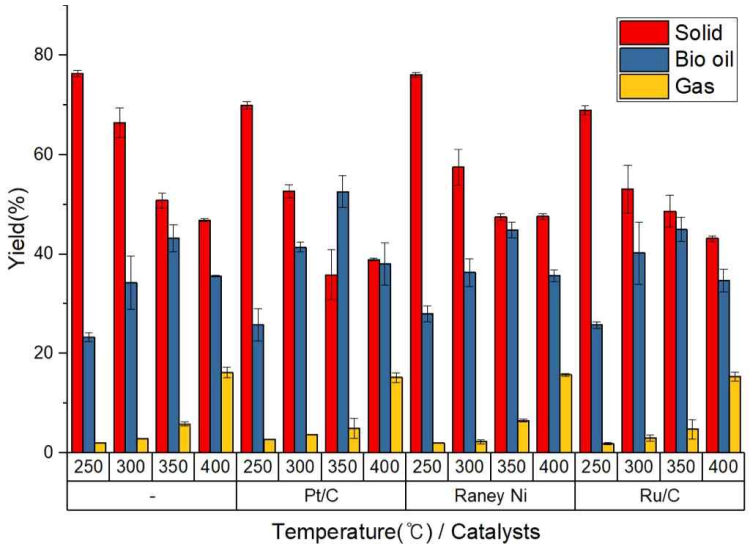
		참나무 (껍질o)	참나무 (껍질x)	소나무 (껍질o)	소나무 (껍질x)
Input	Raw (g)	500.23	500.21	500.00	500.1
Output	Lignin (g)	59.12	59.01	54.54	58.97
	Pulp (g)	235.83	235.7	376.58	219.67
Yeild (%)		58.96	58.92	86.23	55.72

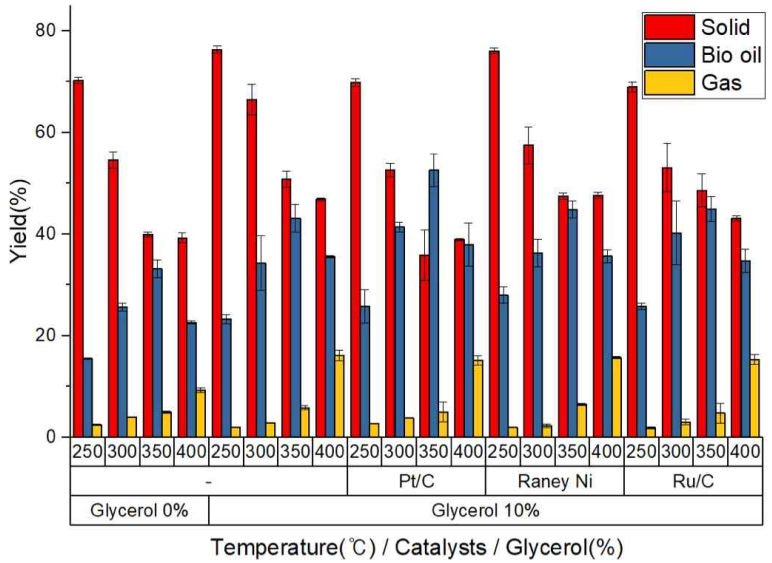
■ Product 수율

1. 참나무(껍질O) 리그닌 - 촉매, 온도별 조건 실험

		-				Pt/C				Ru/C				Raney Ni			
		250℃	300℃	350℃	400℃	250℃	300℃	350℃	400℃	250℃	300℃	350℃	400℃	250℃	300℃	350℃	400℃
Solid	1st	77.00	69.49	52.37	47.10	70.62	54.00	40.87	38.70	69.87	57.87	51.86	43.65	75.49	53.85	46.83	47.08
	2nd	75.70	63.48	49.24	46.62	69.10	51.37	30.86	39.20	67.99	48.34	45.44	42.60	76.59	61.09	48.08	48.17
	Aver.	76.35	66.48	50.81	46.86	69.86	52.68	35.86	38.95	68.93	53.11	48.65	43.13	76.04	57.47	47.45	47.62
Oil	1st	22.37	28.95	40.45	35.41	22.55	40.43	49.35	42.27	26.43	33.96	42.51	32.37	26.43	39.07	46.50	36.90
	2nd	24.14	39.64	45.87	35.82	29.09	42.36	55.82	33.75	25.11	46.54	47.43	37.04	29.60	33.55	43.20	34.44
	Aver.	23.25	34.30	43.16	35.61	25.82	41.39	52.59	38.01	25.77	40.25	44.97	34.71	28.01	36.31	44.85	35.67
Gas	1st	2.06	-	6.29	17.21	-	3.73	2.98	16.10	2.14	3.60	6.67	14.43	-	1.88	6.75	15.48
	2nd	2.04	2.86	5.36	15.10	2.73	3.80	6.93	14.25	1.65	2.42	2.79	16.29	1.99	2.61	6.30	15.98
	Aver.	2.05	2.86	5.82	16.16	2.73	3.76	4.95	15.17	1.90	3.01	4.73	15.36	1.99	2.24	6.53	15.73
Max. press	1st	35.58	-	155.14	295.03	35.91	79.01	152.00	296.69	35.36	79.01	150.35	286.74	35.08	76.91	153.09	296.69
	2nd	35.36	77.90	135.14	288.40	35.14	77.35	154.14	285.08	35.08	77.90	264.00	295.03	35.64	77.90	153.15	288.40
Total		101.65	103.64	99.79	98.63	98.41	97.84	93.40	92.14	96.60	96.37	98.36	93.19	106.04	96.03	98.83	99.03

Catalyst	Temp.	Solid			Oil			Gas			Total
-	250℃	76.35	±	0.65	23.25	±	0.89	2.05	±	0.01	101.65
	300℃	66.48	±	3.00	34.30	±	5.35	2.86	±	0.00	103.64
	350℃	50.81	±	1.56	43.16	±	2.71	5.82	±	0.46	99.79
	400℃	46.86	±	0.24	35.61	±	0.21	16.16	±	1.05	98.63
Pt/C	250℃	69.86	±	0.76	25.82	±	3.27	2.73	±	0.00	98.41
	300℃	52.68	±	1.31	41.39	±	0.97	3.76	±	0.04	97.84
	350℃	35.86	±	5.00	52.59	±	3.24	4.95	±	1.98	93.40
	400℃	38.95	±	0.25	38.01	±	4.26	15.17	±	0.93	92.14
Ru/C	250℃	68.93	±	0.94	25.77	±	0.66	1.90	±	0.24	96.60
	300℃	53.11	±	4.76	40.25	±	6.29	3.01	±	0.59	96.37
	350℃	48.65	±	3.21	44.97	±	2.46	4.73	±	1.94	98.36
	400℃	43.13	±	0.52	34.71	±	2.34	15.36	±	0.93	93.19
Raney Ni	250℃	76.04	±	0.55	28.01	±	1.58	1.99	±	0.00	106.04
	300℃	57.47	±	3.62	36.31	±	2.76	2.24	±	0.37	96.03
	350℃	47.45	±	0.63	44.85	±	1.65	6.53	±	0.22	98.83
	400℃	47.62	±	0.54	35.67	±	1.23	15.73	±	0.25	99.03

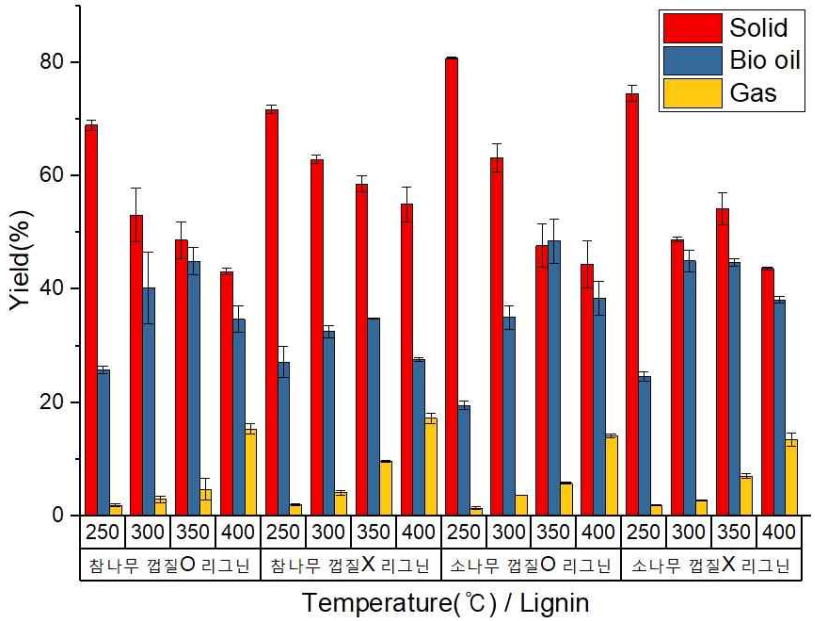




2. 4종 리그닌 - 리그닌별 온도 조건 실험

		참나무(껍질O)				참나무(껍질X)				소나무(껍질O)				소나무(껍질X)			
		250℃	300℃	350℃	400℃	250℃	300℃	350℃	400℃	250℃	300℃	350℃	400℃	250℃	300℃	350℃	400℃
Solid	1st	69.87	57.87	51.86	43.65	71.00	63.68	57.19	51.91	80.92	65.70	51.47	48.59	73.07	49.15	57.09	43.93
	2nd	67.99	48.34	45.44	42.60	72.43	62.17	59.93	58.02	80.65	60.68	43.94	40.17	75.92	48.43	51.32	43.43
	Aver.	68.93	53.11	48.65	43.13	71.71	62.92	58.56	54.96	80.79	63.19	47.70	44.38	74.49	48.79	54.21	43.68
Oil	1st	26.43	33.96	42.51	32.37	29.90	31.49	34.81	27.22	20.29	32.95	44.62	35.36	25.47	43.13	44.04	37.65
	2nd	25.11	46.54	47.43	37.04	24.41	33.67	34.96	28.00	18.76	37.18	52.43	41.43	23.74	46.96	45.33	38.65
	Aver.	25.77	40.25	44.97	34.71	27.16	32.58	34.89	27.61	19.53	35.06	48.52	38.40	24.60	45.04	44.68	38.15
Gas	1st	2.14	3.60	6.67	14.43	1.82	3.73	9.58	18.18	1.60	3.66	5.58	14.56	2.06	2.74	7.45	14.65
	2nd	1.65	2.42	2.79	16.29	2.10	4.57	9.80	16.32	1.24		5.99	13.83	1.83	2.85	6.69	12.35
	Aver.	1.90	3.01	4.73	15.36	1.96	4.15	9.69	17.25	1.42	3.66	5.79	14.19	1.94	2.80	7.07	13.50
Max. press	1st	35.36	79.01	150.35	286.74	35.36	79.01	157.79	290.37	34.92	78.56	155.84	292.82	35.14	79.01	162.43	296.69
	2nd	35.08	77.90	264.00	295.03	35.91	80.11	159.12	301.66	35.14	76.80	153.59	295.03	35.14	79.01	158.01	296.69
Total		96.60	96.37	98.36	93.19	100.83	99.66	103.14	99.83	101.74	101.91	102.01	96.97	101.04	96.63	105.96	95.33

	Temp.	Solid			Oil			Gas			Total
참나무 (껍질O)	250℃	68.93	±	0.94	25.77	±	0.66	1.90	±	0.24	96.60
	300℃	53.11	±	4.76	40.25	±	6.29	3.01	±	0.59	96.37
	350℃	48.65	±	3.21	44.97	±	2.46	4.73	±	1.94	98.36
	400℃	43.13	±	0.52	34.71	±	2.34	15.36	±	0.93	93.19
참나무 (껍질X)	250℃	71.71	±	0.71	27.16	±	2.75	1.96	±	0.14	100.83
	300℃	62.92	±	0.75	32.58	±	1.09	4.15	±	0.42	99.66
	350℃	58.56	±	1.37	34.89	±	0.08	9.69	±	0.11	103.14
	400℃	54.96	±	3.05	27.61	±	0.39	17.25	±	0.93	99.83
소나무 (껍질O)	250℃	80.79	±	0.13	19.53	±	0.77	1.42	±	0.18	101.74
	300℃	63.19	±	2.51	35.06	±	2.11	3.66	±	0.00	101.91
	350℃	47.70	±	3.77	48.52	±	3.91	5.79	±	0.20	102.01
	400℃	44.38	±	4.21	38.40	±	3.04	14.19	±	0.37	96.97
소나무 (껍질X)	250℃	74.49	±	1.42	24.60	±	0.86	1.94	±	0.11	101.04
	300℃	48.79	±	0.36	45.04	±	1.92	2.80	±	0.05	96.63
	350℃	54.21	±	2.89	44.68	±	0.64	7.07	±	0.38	105.96
	400℃	43.68	±	0.25	38.15	±	0.50	13.50	±	1.15	95.33



3. 참나무(껍질O) 리그닌 - 글리세롤 0%, 온도별 조건 실험

		참나무(껍질O)			
		250℃	300℃	350℃	400℃
Solid	1st	70.71	53.48	39.59	39.97
	2nd	69.84	55.71	40.22	38.60
	Aver.	70.28	54.59	39.91	39.29
Oil	1st	15.36	26.22	34.44	22.42
	2nd	15.54	25.07	31.91	22.82
	Aver.	15.45	25.65	33.18	22.62
Gas	1st	2.56	4.00	5.11	9.56
	2nd	2.33	4.01	4.80	8.88
	Aver.	2.44	4.01	4.96	9.22
Max.press	1st	36.24	80.66	159.12	290.06
	2nd	36.46	81.22	155.80	290.06
Total		88.17	84.25	78.04	71.13

■ Gas 조성

1. 참나무(껍질O) 리그닌 - 촉매, 온도별 조건 실험

		-				Pt/C				Ru/C				Raney Ni			
		250℃	300℃	350℃	400℃	250℃	300℃	350℃	400℃	250℃	300℃	350℃	400℃	250℃	300℃	350℃	400℃
Volume (mL)	1st	84.0	-	435.0	1750.0	-	291.5	310.0	2040.0	100.0	218.0	632.5	1570	-	108.0	570.0	1540
	2nd	88.0	144.0	400.0	1470.0	158.0	274.0	774.0	1860.0	102.0	182.0	264.0	1770	112.0	170.0	507.7	1595
	Ave.	86.00	144.00	417.50	1610.00	158.00	282.75	542.00	1950.00	101.00	200.00	448.25	1670.00	112.00	139.00	538.85	1567.50
Gas (area %) 1st	H2	2.39	-	6.45	0.36	-	19.96	26.56	0.89	14.02	16.24	26.33	0.39	-	20.42	28.66	0.31
	N2, O2	13.72	-	5.12	0.89	-	3.42	2.51	1.48	13.35	6.10	2.42	1.03	-	6.74	13.56	0.84
	CH4	2.18	-	32.39	5.74	-	15.20	22.01	4.50	2.33	8.98	22.42	4.93	-	9.97	27.49	4.97
	CO2	80.22	-	39.76	10.23	-	40.93	26.42	9.23	67.43	54.92	30.29	8.08	-	57.00	18.38	9.36
Gas (area %) 2nd	H2	4.36	4.40	9.08	0.25	18.35	14.75	31.45	0.84	35.85	37.86	28.37	0.49	23.26	28.64	19.77	0.33
	N2, O2	12.31	7.16	2.21	0.69	6.52	3.49	2.34	1.43	9.87	5.94	2.68	1.09	10.36	5.96	3.07	0.82
	CH4	4.14	11.69	32.24	5.07	10.21	17.09	23.73	3.97	1.76	7.91	25.00	5.25	7.32	9.76	26.07	5.16
	CO2	76.02	66.63	39.37	9.10	56.83	44.79	23.17	8.00	50.30	41.54	29.07	9.47	54.35	49.58	36.00	9.67

2. 4종 리그닌 - 리그닌별 온도 조건 실험

		참나무(껍질O)				참나무(껍질X)				소나무(껍질O)				소나무(껍질X)			
		250℃	300℃	350℃	400℃	250℃	300℃	350℃	400℃	250℃	300℃	350℃	400℃	250℃	300℃	350℃	400℃
Volume (mL)	1st	100	218	632.5	1570	124.0	286.0	822.0	1930.0	94.0	266.0	540.0	1675.0	126.0	250.0	770.0	1715.0
	2nd	102.0	182.0	264.0	1770.0	140.0	326.0	827.0	1710.0	73.0	215.0	635.0	1595.0	118.0	251.6	650.0	1435.0
	Ave.	101.00	200.00	448.25	1670.00	132.00	306.00	824.50	1820.00	83.50	240.50	587.50	1635.00	122.00	250.80	710.00	1575.00
Gas (area %) 1st	H2	14.02	16.24	26.33	0.39	39.10	31.21	20.81	23.45	27.15	27.77	27.63	27.34	29.17	42.32	31.19	28.66
	N2, O2	13.35	6.10	2.42	1.03	7.32	3.96	2.65	1.68	8.97	5.38	2.91	1.95	8.39	4.52	2.69	1.93
	CH4	2.33	8.98	22.42	4.93	1.82	6.80	22.40	31.28	2.96	6.75	20.89	30.29	4.87	7.54	18.76	30.03
	CO2	67.43	54.92	30.29	8.08	47.36	43.84	34.77	23.62	54.80	45.03	29.28	20.46	51.95	33.82	27.51	19.90
Gas (area %) 2nd	H2	35.85	37.86	28.37	0.49	36.33	26.18	19.22	22.82	29.62		34.10	28.51	34.82	41.90	29.66	28.81
	N2, O2	9.87	5.94	2.68	1.09	7.17	4.26	2.42	1.67	11.58		2.98	2.34	9.05	5.17	3.11	1.96
	CH4	1.76	7.91	25.00	5.25	3.18	6.43	20.76	30.06	2.52		18.27	30.52	2.12	6.20	18.48	29.46
	CO2	50.30	41.54	29.07	9.47	48.45	47.74	36.53	24.63	51.40		26.16	19.69	48.57	34.95	29.58	20.34

3. 참나무(껍질O) 리그닌 - 글리세롤 0%, 온도별 조건 실험

		No catalyst			
		250℃	300℃	350℃	400℃
Volume (mL)	1st	109	188	315	790
	2nd	110.0	195.0	310.0	755.0
	Ave.	109.50	191.50	312.50	772.50
Gas (area%) 1st	H2	2.41	4.02	2.50	12.69
	N2, O2	10.98	7.48	5.08	1.75
	CH4	2.10	10.16	34.15	45.53
	CO2	79.69	72.69	46.62	29.75
Gas (area%) 2nd	H2	2.50	4.99	5.09	10.10
	N2, O2	9.28	6.29	3.34	2.06
	CH4	16.42	9.73	33.08	53.27
	CO2	67.35	71.35	46.29	25.24

■

■ GC-MS(정성)

< Lignin>

(area%)

Groups		참나무 껍질O	참나무 껍질X	소나무 껍질O	소나무 껍질X	케나프
Syringyl		***16.34***	***0.00***	***0.32***	***18.79***	***4.18***
Syringol, 4-ethyl; Phenol, 4-ethenyl-2,6-dimethoxy-	C10H12O3	0.62	-	-	1.03	0.29
Syringaldehyde; Benzaldehyde, 4-hydroxy-3,5-dimethoxy-	C9H10O4	3.61	-	-	7.83	0.82
Syringylpropene; 2,6-Dimethoxy-4-propylphenol	C11H16O3	1.04	-	-	-	-
Acetosyringone; Ethanone, 1-(4-hydroxy-3,5-dimethoxyphenyl)-	C10H12O4	0.39	-	-	0.36	-
Syringylacetone	C11H14O4	4.89	-	0.17	2.90	1.12
Butylsyringone	C12H16O4	4.65	-	0.15	2.76	0.71
Acetyl syringic acid, ethyl ester	C13H16O6	0.78	-	-	0.42	0.14
Benzeneacetic acid, 4-hydroxy-3,5-dimethoxy-, methyl ester	C11H14O5	0.36	-	-	-	0.13
6-Methoxyeugenyl isovalerate	C16H22O4	-	-	-	0.22	-
Homosyringaldehyde	C10H12O4	-	-	-	0.73	0.23
4-Propenyl-2,6-dimethoxyphenol; (E)-2,6-Dimethoxy-4-(prop-1-en-1-yl)phenol	C11H14O3	-	-	-	0.73	0.23
SYRINGIC ACID; Benzoic acid, 4-hydroxy-3,5-dimethoxy-	C9H10O5	-	-	-	0.57	-
Sinapaldehyde; 3,5-Dimethoxy-4-hydroxycinnamaldehyde	C11H12O4	-	-	-	0.92	0.25
(E)-3-(4-Acetoxy-3,5-dimethoxyphenyl)allyl acetate	C15H18O6	-	-	-	0.20	-
Phenol, 4,4'-methylenebis[2,6-dimethoxy-	C17H20O6	-	-	-	0.12	-
trans-Sinapyl alcohol	C11H14O4	-	-	-	-	0.27
Guaiacyl		***11.27***	***8.02***	***19.95***	***13.46***	***7.93***
4-Propylguaiacol; Phenol, 2-methoxy-4-propyl-	C10H14O2	0.62	0.46	1.26	0.42	0.30
Guaiacylacetone; 2-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-	C10H12O3	2.36	1.30	1.63	1.19	0.74
Ethyl (E)-ferulate	C12H14O4	0.39	-	-	1.98	0.51
3,4-Divanillyltetrahydrofuran	C20H24O5	4.30	-	-	-	-
lignostilbene; (E)-3,3'-Dimethoxy-4,4'-dihydroxystilbene	C16H16O4	3.60	-	8.01	5.25	3.22
Vanillin	C8H8O3	-	1.14	1.25	-	-
Butyrovanillone	C11H14O3	-	4.41	5.34	2.98	1.78
Homovanillic acid	C9H10O4	-	0.28	-	0.16	0.13
Coniferyl aldehyde	C10H10O3	-	0.43	0.90	0.93	0.38
5-Vinylguaiacol; Phenol, 5-ethenyl-2-methoxy-	C9H10O2	-	-	0.09	-	-
Dihydroconiferyl alcoho; Benzenepropanol, 4-hydroxy-3-methoxy-	C10H14O3	-	-	0.52	-	-
Methyl homovanillate; Benzeneacetic acid, 4-hydroxy-3-methoxy-, methyl ester	C10H12O4	-	-	0.40	-	-
2-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-	C10H12O4	-	-	0.17	-	-
Ethyl vanillat; Benzoic acid, 4-hydroxy-3-methoxy-, ethyl ester	C10H12O4	-	-	0.21	-	-
1'-Hydroxyeugenol; 4-(1-Hydroxyallyl)-2-methoxyphenol	C10H12O3	-	-	0.18	-	0.59
4-Ethylguaiacol; Phenol, 4-ethyl-2-methoxy-	C9H12O2	-	-	-	0.10	0.11
Eugenyl isovalerate; Butanoic acid, 3-methyl-, 2-methoxy-4-(2-propenyl)phenyl ester	C15H20O3	-	-	-	0.19	-
2-Propanone, 1-hydroxy-3-(4-hydroxy-3-methoxyphenyl)-	C10H12O4	-	-	-	0.15	0.09
3',4'-Dimethoxybutyrophenone; Butan-1-one, 1-(3,4-dimethoxyphenyl)-	C12H16O3	-	-	-	0.11	-
Phenol, 2-methoxy-4-(1-propenyl)-, (Z)-	C10H12O2	-	-	-	-	0.08
Poly aromatics		***40.08***	***53.10***	***45.17***	***1.66***	***57.61***
Anthanthrene; Dibenzo[def,mno]chrysene	C22H12	3.68	-	-	-	1.21
4-Hydroxy-5,10-dioxo-3a,12a-dihydroanthra(2,3-b)furo(3,2-d)furan (6,8-dideoxyversicolorina)	C18H10O5	0.21	-	-	-	-
Benzo[ghi]perylene, 4-methyl-	C23H14	5.58	3.75	-	-	1.88
Pentacene	C22H14	0.72	-	-	-	0.44
Benzo[ghi]perylene	C22H12	29.89	-	-	-	8.36
(1R,6S)-gamma-himachalene; (4aS,9aR)-3,5,5,9-Tetramethyl-2,4a,5,6,7,9a-hexahydro-1H-benzo[7]annulene	C15H24	-	0.33	0.23	-	-
Isolongifolene; 2H-2,4a-Methanonaphthalene, 1,3,4,5,6,7-hexahydro-1,1,5,5- tetramethyl-, (2S)-	C15H24	-	2.50	1.75	-	-
Sandaracopimarinal; (1R,4aR,4bS,7R,10aR)-1,4a,7-Trimethyl-7-vinyl-1,2,3,4,4a,4b,5,6,7,9,10,10a- dodecahydrophenanthrene-1-carbaldehyde	C20H30O	-	0.26	-	-	-
2-Isopropyl-10-methylphenanthrene	C18H18	-	0.53	0.24	-	-
Isopimaric acid	C20H30O2	-	1.85	1.37	-	-
Methyl dehydroabietate	C21H30O2	-	10.42	8.18	-	1.95
Methyl 6-dehydrodehydroabietate; 1-Phenanthrenecarboxylic acid, 1,2,3,4,4a,10a-hexahydro-1,4a-dimethyl-7-(1-methylethyl)-, methyl ester, [1R-(1.alpha.,4a.beta.,10a.alpha.)]-	C21H28O2	-	4.17	-	-	-
1-Phenanthrenecarboxylic acid,1,2,3,4,4a,9,10,10a-octahydro-1,4a-dimethyl-7-(1-methylethyl)-, [1S-(1.alpha.,4a.alpha.,10a.beta.)]-	C20H28O2	-	24.42	23.11	-	5.10
7-Oxodehydroabietic acid, methyl ester	C21H28O3	-	0.58	-	-	-
1-Phenanthrenecarboxylicacid,1,2,3,4,4a,9,10,10a-octahydro-1,4a-dimethyl-7-(1-methylethyl)-9-oxo-, methyl ester	C21H28O3	-	4.29	6.10	-	-
Calamenene; Naphthalene, 1,2,3,4-tetrahydro-1,6-dimethyl-4-(1-methylethyl)-, (1S-cis)-	C15H22	-	-	0.18	-	-
Calamene; Cadina-1(10),6,8-triene	C15H22	-	-	0.29	-	-
Cadalin; Naphthalene, 1,6-dimethyl-4-(1-methylethyl)-	C15H18	-	-	0.19	-	-
Cadin-1,3,5-trien-5-ol; 1-Naphthalenol, 5,6,7,8-tetrahydro-2,5-dimethyl-8-(1-methyl ethyl)-	C15H22O	-	-	0.18	-	-
Podocarp-7-en-3-one,13.beta.-methyl-13-vinyl-	C20H30O	-	-	0.30	-	-
1-Phenanthrenecarboxylic acid, 7-ethenyl-1,2,3,4,4a,4b,5,6,7,8,10,10a-dodecahydro-1,4a,7-trimethyl-, methyl ester,[1R-(1.alpha.,4a.beta.,4b.alpha.,7.alpha., 1 0a.alpha.)]-	C21H32O2	-	-	0.79	-	-
7-Ethenyl-1,4a,7-trimethyl-3,4,6,8,8a,9,10,10a-octahydro-2H-phenanthrene-1-carboxylic acid	C20H30O2	-	-	2.17	-	-
1,5-Dihydroxy-6-methoxyxanthone	C14H10O5	-	-	0.09	-	-
methyl 4-methylnaphthalen-1-yl ether	C12H12O	-	-	-	0.32	-
1-Naphthol, 6,7-dimethyl-	C12H12O	-	-	-	0.32	-
6-Hydroxy-8-methoxy-3-methyl-3,4-dihydroisochromen-1-one	C11H12O4	-	-	-	1.02	-
Benzo[k]fluoranthene	C20H12	-	-	-	-	12.09
Benzo[a]pyrene	C20H12	-	-	-	-	5.19
Benzo[a]naphthacene	C22H14	-	-	-	-	0.17
Perylene	C20H12	-	-	-	-	0.18

Dibenz[a,j]anthracene	C22H14	-	-	-	-	0.40
Perylene, 3-methyl-	C21H14	-	-	-	-	5.26
8H-Indeno[2,1-b]phenanthrene	C21H14	-	-	-	-	1.46
10-Methylbenzo(a)pyrene	C21H14	-	-	-	-	2.76
13H-Dibenzo[a,h]fluorene	C21H14	-	-	-	-	1.51
Indeno[1,2,3-cd]pyrene	C22H12	-	-	-	-	8.39
7,10-Dimethylbenzo(a)pyrene	C22H16	-	-	-	-	1.26
Other aromatics		***2.11***	***6.56***	***1.52***	***9.17***	***0.9***
Isovanilline; Benzaldehyde, 3-hydroxy-4-methoxy-	C8H8O3	1.05	1.14	-	2.67	0.48
Ethyl diphenylacetate; Acetic acid, diphenyl-, ethyl ester	C16H16O2	0.27	-	-	-	-
4'-Butoxy-2'-methylacetophenone	C13H18O2	0.79	-	0.23	-	-
Isovanillic acid; 3-Hydroxy-4-methoxybenzoic acid	C8H8O4	-	0.29	-	0.31	0.06
5-[2-(4-Hydroxy-3-methoxyphenyl)ethyl]benzene-1,3- diol, trimethyl ether	C18H22O4	-	0.33	-	-	-
lignostilbene; (E)-3,3'-Dimethoxy-4,4'-dihydroxystilbene	C16H16O4	-	4.80	-	-	-
o-Cymene	C10H14	-	-	0.14	-	-
1-(2-Methoxy-5-methylphenyl)propan-1-one	C11H14O2	-	-	0.24	-	-
2-(4'-Methoxyphenyl)-2-(3'-methyl-4'methoxyphenyl)propane	C18H22O2	-	-	0.22	-	-
Phthalic acid, di(2,3-dimethylphenyl) ester	C24H22O4	-	-	0.69	-	-
Phenol, 4-ethyl-	C8H10O	-	-	-	0.18	-
Phenol, 5-ethenyl-2-methoxy-	C9H10O2	-	-	-	0.42	0.11
2,3-Dimethoxyphenol	C8H10O3	-	-	-	0.13	-
2-Methoxyhydroquinone; 1,4-Benzenediol, 2-methoxy-	C7H8O3	-	-	-	0.11	-
Ethanone, 1-(3-hydroxy-4-methoxyphenyl)-	C9H10O3	-	-	-	0.19	-
Ethylparaben	C9H10O3	-	-	-	0.09	-
Hexylresorcinol	C12H18O2	-	-	-	0.49	-
p-Hydroxycinnamic acid, ethyl ester	C11H12O3	-	-	-	4.58	-
1-(benzo[d][1,3]dioxol-4-yl)propan-1-one	C10H10O3	-	-	-	-	0.07
Diphenylacetylene	C14H10	-	-	-	-	0.18
Cyclic		***1.20***	***11.05***	***2.25***	***5.8***	***7.82***
Furan-2,5-dicarbaldehyde; 2,5-Furandicarboxaldehyde	C6H4O3	0.35	0.41	0.22	0.17	-
Ethyl pentofuranoside; Ethyl .beta.-d-riboside	C7H14O5	0.23	-	-	1.66	0.14
Benzocyclodecene, tetradecahydro-	C14H26	0.62	-	-	-	-
3-Methyl-2-oxo-2H-pyrane-6-carboxylic acid	C7H6O4	-	7.49	0.18	-	-
2-Propenylcyclopropanecarboxylic acid, ethyl ester	C9H14O2	-	0.20	-	-	-
1,3-Dioxolane, 2-methyl-2-(4-methyl-3-methylenepentyl)-	C11H20O2	-	1.45	-	-	-
(R-(R*,R*))-4-(1,5-Dimethyl-3-oxohexyl)-1-cyclohexenecarboxylic acid	C15H24O3	-	1.18	1.38	-	0.28
(Z)-18-Octadec-9-enolide	C18H32O2	-	0.32	-	-	3.56
Furan, 2-(1,2-diethoxyethyl)-	C10H16O3	-	-	0.09	-	-
(+)-Longicamphenylone	C14H22O	-	-	0.37	-	-
(2S,6R,7S,8E)-(+)-2,7-Epoxy-4,8-megastigmadiene	C13H20O	-	-	-	0.17	-
Ethyl 2,4-dimethyl-3-furoate; 3-Furancarboxylic acid, 2,4-dimethyl-, ethyl ester	C9H12O3	-	-	-	0.94	-
Levoglucosan; .beta.-D-Glucopyranose, 1,6-anhydro-	C6H10O5	-	-	-	0.28	-
Ethyl hexopyranoside #; Ethyl .alpha.-d-glucopyranoside	C8H16O6	-	-	-	2.58	-
5-Hydroxymethylfurfural	C6H6O3	-	-	-	-	1.21
Isolongifolene; 2H-2,4a-Methanonaphthalene, 1,3,4,5,6,7-hexahydro-1,1,5,5- tetramethyl-, (2S)-	C15H24	-	-	-	-	0.40
5-Cyclohexyl-1-pentene	C11H20	-	-	-	-	0.12
1-Cyclohexylheptene	C13H24	-	-	-	-	0.10
Cyclodecacyclododecene,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16 ,17,18-octadecahydro-	C20H36	-	-	-	-	2.01
Fatty Acids		***18.36***	***13.10***	***25.13***	***40.36***	***8.44***
Pentanoic acid, 4-oxo-, ethyl ester	C7H12O3	3.18	1.63	1.51	-	0.21
Dodecanoic acid, methyl ester	C13H26O2	8.68	3.75	4.35	7.29	3.04
Hexadecanoic acid, ethyl ester	C18H36O2	2.63	0.97	1.49	12.42	0.92
9,12-Octadecadienoic acid, ethyl ester	C20H36O2	2.06	-	-	-	-
(E)-9-Octadecenoic acid ethyl ester	C20H38O2	1.82	-	6.30	5.23	2.35
Diethyl azelate	C13H24O4	-	0.69	2.12	0.44	0.17
cis-13-Octadecenoic acid	C18H34O2	-	0.27	-	-	-
Linoleic acid ethyl ester	C20H36O2	-	0.39	0.75	4.06	1.05
Ethyl Oleate	C20H38O2	-	4.04	6.30	-	-
Octadecanoic acid, ethyl ester	C20H40O2	-	0.29	0.37	2.30	0.14
Docosanoic acid, ethyl ester	C24H48O2	-	1.08	-	1.85	-
Octanoic acid, ethyl ester	C10H20O2	-	-	0.32	-	-
Nonanoic acid, 9-oxo-, ethyl ester	C11H20O3	-	-	0.14	0.19	-
Diethyl suberate	C12H22O4	-	-	0.48	-	-
n-Hexadecanoic acid	C16H32O2	-	-	0.13	2.82	-
Heptadecanoic acid, ethyl ester	C19H38O2	-	-	0.24	0.31	-
cis-Vaccenic acid	C18H34O2	-	-	0.63	-	-
Pentanoic acid	C5H10O2	-	-	-	0.15	-
Triethyl citrate	C12H20O7	-	-	-	1.50	-
Oleic Acid	C18H34O2	-	-	-	0.54	-
Eicosanoic acid, ethyl ester	C22H44O2	-	-	-	1.24	-
Ethyl hexadecanedioate	C20H38O4	-	-	-	-	0.57
Total		***89.36***	***91.83***	***94.34***	***89.24***	***86.99***

< 참나무 껍질O depolymerization 250 °C, Gly 10%, 30 min >

(area%)

Groups		No cat	Pt/C	Ru/C	Raney Ni
Syringyl		***14.37***	***21.20***	***21.85***	***18.61***
Phenol, 2,6-dimethoxy-	C8H10O3	5.83	5.67	6.16	7.11
4-methylsyringol; 3,5-Dimethoxy-4-hydroxytoluene	C9H12O3	0.27	3.69	0.47	0.47
4-Ethylsyringol; 4-Ethyl-2,6-dimethoxyphenol	C10H14O3	0.77	2.67	5.65	0.91
4-Propylsyringol; 2,6-Dimethoxy-4-propylphenol	C11H16O3	-	1.03	0.16	-
Syringaldehyde ; Benzaldehyde, 4-hydroxy-3,5-dimethoxy-	C9H10O4	0.91	0.81	0.89	1.14
(E)-4-Propenylsyringol; (E)-2,6-Dimethoxy-4-(prop-1-en-1- yl)phenol	C11H14O3	0.12	-	-	0.17
4-Acetylsyringol; Acetosyringon; Ethanone, 1-(4-hydroxy-3,5- dimethoxyphenyl)-	C10H12O4	2.23	2.04	2.35	3.00
Syringylacetone	C11H14O4	2.09	2.47	2.35	2.70
Syringyl alcohol ; 3,5-Dimethoxy-4-hydroxybenzeneethanol	C10H14O4	0.11	-	0.24	0.15
Butylsyringone	C12H16O4	1.83	2.49	2.54	2.56
Acetyl syringic acid, ethyl ester	C13H16O6	0.21	0.33	0.29	0.39
Propiosyringone; 1-Propanone, 1-(4-hydroxy-3,5-dimethoxyphenyl)-	C11H14O4	-	-	-	-
Dihydrosyringenin; 3-Syringylpropanol	C11H16O4	-	-	0.74	-
Guaiacyl		***4.01***	***11.81***	***4.22***	***4.90***
Guaiacol; Phenol, 2-methoxy-	C7H8O2	2.93	2.80	2.98	3.27
5-Methylguaiacol; m-Creosol; 2-Methoxy-5-methylphenol	C8H10O2	-	4.23	0.49	-
4-Ethylguaiacol; Phenol, 4-ethyl-2-methoxy-	C9H12O2	0.99	3.55	-	1.41
4-Propylguaiacol; Phenol, 2-methoxy-4-propyl-	C10H14O2	0.08	1.01	0.19	0.22
Benzaldehyde, 3-hydroxy-4-methoxy-	C8H8O3	-	-	-	-
Allylguaiacol; Eugenol	C10H12O2	-	0.11	-	-
Guaiacylacetone; 2-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-	C10H12O3	-	0.11	-	-
4-(2-Hydroxyethyl)guaiacol; Homovanillyl alcohol	C9H12O3	-	-	0.56	-
3-(4-guaiacyl)propanol; Benzenepropanol, 4-hydroxy-3- methoxy-	C10H14O3	-	-	-	-
Poly aromatics		***0.91***	***0.32***	***0.31***	***0.81***
Naphthalene	C10H8	-	0.22	-	0.43
7-Methoxy-1-naphthol	C11H10O2	0.13	-	0.14	0.17
2-Naphthalenol, 3-methoxy-	C11H10O2	-	-	-	-
1,6-Dimethoxynaphthalene	C12H12O2	-	-	-	-
Naphthalene, 2,3-dimethoxy-	C12H12O2	-	-	-	-
1,6-Dimethoxynaphthalene	C12H12O2	-	-	-	-
Retene	C18H18	-	-	-	-
2-Isopropyl-10-methylphenanthrene	C18H18	-	-	-	-
Methyl dehydroabietate	C21H30O2	0.78	0.10	0.17	0.20
8-Isopropyl-1,3-dimethylphenanthrene	C19H20	-	-	-	-
Other aromatics		***20.06***	***21.00***	***23.15***	**27.10**
Phenol	C6H6O	0.09	0.09	0.09	-
p-Cresol	C7H8O	-	0.06	-	-
o-Cresol; Phenol, 2-methyl-	C7H8O	-	-	-	-
Creosol	C8H10O2	0.18	-	-	0.41
Catechol	C6H6O2	0.32	0.53	0.58	0.49
1-Propanone, 1-(5-methyl-2-thienyl)-	C8H10OS	0.12	-	-	-
2-Acetyl-4-methylphenol; o-Acetyl-p-cresol	C9H10O2	-	-	-	-
3-methoxycatechol; 1,2-Benzenediol, 3-methoxy-	C7H8O3	0.19	0.18	-	0.29
Hydroquinone	C6H6O2	-	-	-	-
4-Methylcatechol; 1,2-Benzenediol, 4-methyl-	C7H8O2	-	0.34	-	-
3-Methylcatechol; 1,2-Benzenediol, 3-methyl-	C7H8O2	-	-	-	-
Phenol, 4-methoxy-3-methyl-	C8H10O2	-	-	-	-
2,3-Dimethoxyphenol	C8H10O3	-	-	-	-
Phenol, 3,4-dimethoxy-	C8H10O3	-	-	-	-
5-Methoxy-m-cresol; 3-Methoxy-5-methylphenol	C8H10O2	-	-	-	-
2,6-Dimethoxyhydroquinone	C8H10O4	0.13	-	0.18	0.25
1,4-Benzenedicarboxaldehyde, 2-methyl- ; 2-Methylterephthalaldehyde	C9H8O2	-	-	-	-
Ethanone, 1-(2-hydroxy-5-methylphenyl)-	C9H10O2	0.08	-	-	-
Ethanone, 1-(2-hydroxy-6-methoxyphenyl)-	C9H10O3	-	-	-	-
1,2,3-Trimethoxybenzene	C9H12O3	-	0.09	-	-
4-Ethylcatechol	C8H10O2	-	-	-	-
1,4-Benzenediol, 2,3,5-trimethyl- ; Trimethylhydroquinone	C9H12O2	-	-	-	-
Ethanone, 1-(2,3,4-trihydroxyphenyl)-	C8H8O4	-	-	-	-
Vanillin	C8H8O3	3.34	2.23	3.05	3.17
3-Ethoxy-4-methoxyphenol	C9H12O3	-		-	-
Phenol, 2-methoxy-4-(2-propenyl)-, acetate; Aceto eugenol	C12H14O3	-	0.33	0.17	-
3-Acetylphenol; Ethanone, 1-(3-hydroxyphenyl)-	C8H8O2	0.08	-	-	-
2-methoxy-5-acetylphenol; Ethanone, 1-(3-hydroxy-4-methoxyphenyl)-	C9H10O3	-	-	-	-
Apocynin	C9H10O3	1.89	1.58	1.94	2.24
Benzene, 1,2,3-trimethoxy-5-methyl-	C10H14O3	-	-	-	-
2-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-	C10H12O3	2.54	2.66	3.85	3.05
3-Hydroxy-4-methoxybenzoic acid	C8H8O4	0.32	0.59	0.55	0.52
Flopropione	C9H10O4	-	-	-	-
3,4-Dimethoxyphenylacetone	C11H14O3	-	-	-	-
1-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-	C10H12O3	0.13	0.35	0.31	-
Butyrovanillone	C11H14O3	3.61	4.42	4.40	4.89
Homovanillic acid	C9H10O4	-	-	2.40	-
Benzenepropanol, 4-hydroxy-3-methoxy-	C10H14O3	2.37	1.87	-	3.08
Phenol, 2-methoxy-4-methyl-6-[propenyl]-	C11H14O2	-	-	-	-
2,3-Dimethoxy-5-aminocinnamonitrile	C11H12N2O2	0.29	0.35	0.35	0.40
5-(3-Hydroxypropyl)-2,3-dimethoxyphenol	C11H16O4	0.72	0.51	-	1.01
Asarone	C12H16O3	-	-	-	-
Benzene, 1,2,3-trimethoxy-5-(2-propenyl)-	C12H16O3	-	-	-	-
3,4-Divanillyltetrahydrofuran	C20H24O5	-	2.16	2.32	3.48
1-(2,4-Dihydroxyphenyl)-2-(3,4-dimethoxyphenyl)ethanone	C16H16O5	-	0.10	-	-
1-(2,4-Dihydroxyphenyl)-2-(3,5-	C17H18O5	-	-	-	-
Dehydroabietate	C20H28O2	3.64	2.55	2.95	3.81
3,4-Dimethoxyphenol, 2- methylpropionate		-	-	-	-
Alkanes(Paraffins)		***1.99***	***1.23***	***2.21***	***2.29***
Propane, 1,1-diethoxy-	C7H16O2	0.36	0.14	0.48	-
1,3,5-Trioxane	C3H6O3	1.63	1.09	1.73	2.29
Propanal ethyl isopentyl acetal; 1-(1-Ethoxypropoxy)-3-methylbutane	C10H22O2	-	-	-	-
Cyclic		***4.78***	***3.88***	***5.14***	***6.62***
Oxazolidin-2-one	C3H5NO2	-	-	-	0.36
Butyrolactone	C4H6O2	4.53	3.53	4.75	5.89
2-Cyclopenten-1-one, 3-methyl-	C6H8O	-	-	-	-
1,2-Cyclopentanedione, 3-methyl-	C6H8O2	-	-	-	-
2-Cyclopenten-1-one, 2-hydroxy-3-methyl-	C6H8O2	0.25	0.35	0.38	0.37
2-Cyclopenten-1-one, 2,3-dimethyl-	C7H10O	-	-	-	-
Fatty Acids		***10.03***	***8.51***	***13.20***	***18.77***
Propanoic acid	C3H6O2	-	-	-	-
Butanoic acid, 4-hydroxy-	C4H8O3	-	-	-	-

Methyltartronic acid	C4H6O5	-	0.13	-	0.95
Lactic acid; Propanoic acid, 2-hydroxy-, ethyl ester	C5H10O3	-	-	-	-
Pentanoic acid, 4-oxo-	C5H8O3	1.13	0.49	1.22	1.12
Pentanoic acid, 4-oxo-, ethyl ester	C7H12O3	-	0.11	0.06	-
Butanoic acid, anhydride	C8H14O3	-	-	0.76	6.29
Butanoic acid, 2-methylpropyl ester	C8H16O2	6.16	-	8.15	6.62
Propanoic acid, 2-methyl-, anhydride	C8H14O3	-	5.19	0.16	-
Pentanoic acid, 4-oxo-, 2-methylpropyl ester	C9H16O3	0.35	0.10	-	0.24
Dodecanoic acid, methyl ester	C13H26O2	2.39	2.49	2.84	3.55
Pentanoic acid, 2-methyl-4-oxo-					
alcohol		***0.44***	***0.30***	***0.53***	***0.67***
1,3-Propanediol	C3H8O2	0.44	0.30	0.36	0.67
Ethanol, 2,2'-oxybis-	C4H10O3	-	-	-	-
1,2-Propanediol, 3-methoxy-	C4H10O3	-	-	-	-
1-Propanol, 2-(2-hydroxypropoxy)-	C6H14O3	-	-	0.16	-
Glycerol derived		***34.58***	***15.14***	***12.50***	***8.46***
3-Ethoxy-1,2-propanediol; Glycerol 1-ethyl ether	C5H12O3	-	-	0.09	-
Glycerol triethyl ether	C9H20O3	-	-	-	-
1,3-Dioxolane-4-methanol, 2-ethyl-	C6H12O3	-	2.63	2.47	0.09
Glycerin	C3H8O3	13.28	4.36	0.90	-
1,2,3-Propanetriol, 1-acetate	C5H10O4	1.13	1.13	1.64	1.52
Glycerol 1,2-diacetate	C7H12O5	-	-	-	-
Alpha-monopropionin	C6H12O4	-	-	-	-
Hydroxyacetone; 2-Propanone, 1-hydroxy-	C3H6O2	7.88	-	-	-
Ethylene glycol Formate Isobutyrate	C7H12O4	6.11	7.02	-	-
2,3-dihydroxypropyl isobutyrate	C7H14O4	6.18	-	7.40	6.84
Total		**91.16**	**83.37**	**83.11**	**88.22**

< 참나무 껍질O depolymerization 300 °C, Gly 10%, 30 min >

(area%)

Groups		No cat	Pt/C	Ru/C	Raney Ni
Syringyl		***25.71***	***32.46***	***25.28***	***25.55***
Phenol, 2,6-dimethoxy-	C8H10O3	13.35	14.39	13.54	14.33
4-methylsyringol; 3,5-Dimethoxy-4-hydroxytoluene	C9H12O3	2.14	6.06	2.48	2.65
4-Ethylsyringol; 4-Ethyl-2,6-dimethoxyphenol	C10H14O3	1.78	3.59	1.89	2.63
4-Propylsyringol; 2,6-Dimethoxy-4-propylphenol	C11H16O3	0.50	1.72	0.64	-
Syringaldehyde ; Benzaldehyde, 4-hydroxy-3,5-dimethoxy-	C9H10O4	0.72	0.28	0.64	-
(E)-4-Propenylsyringol; (E)-2,6-Dimethoxy-4-(prop-1-en-1- yl)phenol	C11H14O3	-	0.49	0.31	0.37
4-Acetylsyringol; Acetosyringon; Ethanone, 1-(4-hydroxy-3,5- dimethoxyphenyl)-	C10H12O4	2.48	1.93	2.07	2.23
Syringylacetone	C11H14O4	3.43	2.54	3.01	2.75
Syringyl alcohol ; 3,5-Dimethoxy-4-hydroxybenzeneethanol	C10H14O4	0.19	-	0.22	0.19
Propiosyringone; 1-Propanone, 1-(4-hydroxy-3,5-dimethoxyphenyl)-	C11H14O4	0.46	0.97	0.48	0.40
Dihydrosyringenin; 3-Syringylpropanol	C11H16O4	0.66	0.49	-	-
Guaiacyl		***17.28***	***20.58***	***13.73***	***13.25***
Guaiacol; Phenol, 2-methoxy-	C7H8O2	7.62	8.20	7.81	7.47
5-Methylguaiacol; m-Creosol; 2-Methoxy-5-methylphenol	C8H10O2	1.49	5.98	2.06	1.91
4-Ethylguaiacol; Phenol, 4-ethyl-2-methoxy-	C9H12O2	2.05	4.61	2.59	3.04
4-Propylguaiacol; Phenol, 2-methoxy-4-propyl-	C10H14O2	0.41	1.56	0.64	0.66
Benzaldehyde, 3-hydroxy-4-methoxy-	C8H8O3	-	-	-	-
Allylguaiacol; Eugenol	C10H12O2	-	0.23	0.18	0.17
Guaiacylacetone; 2-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-	C10H12O3	5.14	-	-	-
4-(2-Hydroxyethyl)guaiacol; Homovanillyl alcohol	C9H12O3	0.57	-	0.46	-
3-(4-guaiacyl)propanol; Benzenepropanol, 4-hydroxy-3- methoxy-	C10H14O3	-	-	-	-
Poly aromatics		***1.17***	***0.67***	***0.91***	***1.03***
Naphthalene	C10H8	-	-	-	0.25
7-Methoxy-1-naphthol	C11H10O2	0.40	-	0.44	-
2-Naphthalenol, 3-methoxy-	C11H10O2	-	0.40	-	-
1,6-Dimethoxynaphthalene	C12H12O2	-	-	0.25	0.16
Naphthalene, 2,3-dimethoxy-	C12H12O2	-	-	-	-
1,6-Dimethoxynaphthalene	C12H12O2	0.23	-	-	-
Retene	C18H18	-	-	-	-
2-Isopropyl-10-methylphenanthrene	C18H18	0.15	-	-	-
Methyl dehydroabietate	C21H30O2	0.40	0.27	0.22	0.61
8-Isopropyl-1,3-dimethylphenanthrene	C19H20	-	-	-	-
Other aromatics		**23.22**	**21.58**	**24.06**	**20.91**
Phenol	C6H6O	0.47	0.24	0.33	0.22
o-Cresol; Phenol, 2-methyl-	C7H8O	-	-	0.17	-
Catechol	C6H6O2	1.27	1.09	0.93	0.96
2-Acetyl-4-methylphenol; o-Acetyl-p-cresol	C9H10O2	-	-	-	-
3-methoxycatechol; 1,2-Benzenediol, 3-methoxy-	C7H8O3	1.53	1.98	4.61	1.91
Hydroquinone	C6H6O2	-	-	-	-
4-Methylcatechol; 1,2-Benzenediol, 4-methyl-	C7H8O2	0.16	0.40	-	-
3-Methylcatechol; 1,2-Benzenediol, 3-methyl-	C7H8O2	0.16	-	-	-
Phenol, 4-methoxy-3-methyl-	C8H10O2	-	-	0.17	-
2,3-Dimethoxyphenol	C8H10O3	-	-	-	-
Phenol, 3,4-dimethoxy-	C8H10O3	-	0.56	-	0.69
5-Methoxy-m-cresol; 3-Methoxy-5-methylphenol	C8H10O2	-	-	-	-
2,6-Dimethoxyhydroquinone	C8H10O4	-	0.20	-	-

1,4-Benzenedicarboxaldehyde, 2-methyl- ; 2-Methylterephthalaldehyde	C9H8O2	-	-	-	-
Ethanone, 1-(2-hydroxy-5-methylphenyl)-	C9H10O2	0.16	-	0.22	0.19
Ethanone, 1-(2-hydroxy-6-methoxyphenyl)-	C9H10O3	-	-	0.14	-
1,2,3-Trimethoxybenzene	C9H12O3	0.37		0.39	0.36
4-Ethylcatechol	C8H10O2	-	-	-	-
1,4-Benzenediol, 2,3,5-trimethyl- ; Trimethylhydroquinone	C9H12O2	-	-	-	-
Ethanone, 1-(2,3,4-trihydroxyphenyl)-	C8H8O4	-	-	-	-
Vanillin	C8H8O3	3.30	1.07	1.95	1.57
3-Ethoxy-4-methoxyphenol	C9H12O3	-	-	-	-
Phenol, 2-methoxy-4-(2-propenyl)-, acetate; Aceto eugenol	C12H14O3	0.16	-	-	-
3-Acetylphenol; Ethanone, 1-(3-hydroxyphenyl)-	C8H8O2	-	-	0.20	-
2-methoxy-5-acetylphenol; Ethanone, 1-(3-hydroxy-4-methoxyphenyl)-	C9H10O3	2.55	-	-	-
Apocynin	C9H10O3	2.55	2.04	2.04	2.10
Benzene, 1,2,3-trimethoxy-5-methyl-	C10H14O3	-	0.16	-	-
2-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-	C10H12O3	-	5.47	4.79	4.44
Flopropione	C9H10O4	-	-	-	-
3,4-Dimethoxyphenylacetone	C11H14O3	0.14	-	-	-
1-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-	C10H12O3	0.28	0.65	0.32	0.23
Butyrovanillone	C11H14O3	0.33	0.20	0.18	0.23
Benzenepropanol, 4-hydroxy-3-methoxy-	C10H14O3	1.99	1.59	1.61	-
Phenol, 2-methoxy-4-methyl-6-[propenyl]-	C11H14O2	-	-	-	-
2,3-Dimethoxy-5-aminocinnamonitrile	C11H12N2O2	0.75	0.63	0.71	0.67
5-(3-Hydroxypropyl)-2,3-dimethoxyphenol	C11H16O4	0.66	-	0.59	0.64
Asarone	C12H16O3	-	0.19	0.21	0.21
Benzene, 1,2,3-trimethoxy-5-(2-propenyl)-	C12H16O3	0.20	0.18	-	-
3,4-Divanillyltetrahydrofuran	C20H24O5	2.05	2.09	1.82	2.09
1-(2,4-Dihydroxyphenyl)-2-(3,4-dimethoxyphenyl)ethanone	C16H16O5	-	0.31	-	-
1-(2,4-Dihydroxyphenyl)-2-(3,5-	C17H18O5	-	-	-	-
Dehydroabietate	C20H28O2	4.17	2.54	2.70	4.38
3,4-Dimethoxyphenol, 2- methylpropionate					
Alkanes(Paraffins)		***2.16***	***1.11***	***2.40***	***1.27***
Propane, 1,1-diethoxy-	C7H16O2	1.71	0.63	1.36	0.63
1,3,5-Trioxane	C3H6O3	0.44	0.48	1.04	0.64
Propanal ethyl isopentyl acetal; 1-(1-Ethoxypropoxy)-3-methylbutane	C10H22O2	-	-	-	-
Cyclic		***2.38***	***2.56***	***3.08***	***2.31***
Oxazolidin-2-one	C3H5NO2	-	-	-	-
Butyrolactone	C4H6O2	2.22	2.28	2.89	2.07
2-Cyclopenten-1-one, 3-methyl-	C6H8O	-	-	-	-
1,2-Cyclopentanedione, 3-methyl-	C6H8O2	-	0.27	-	-
2-Cyclopenten-1-one, 2-hydroxy-3-methyl-	C6H8O2	0.16	-	0.20	0.24
2-Cyclopenten-1-one, 2,3-dimethyl-	C7H10O	-	-	-	-
Fatty Acids		***10.85***	***6.24***	***9.40***	***7.80***
Propanoic acid	C3H6O2	-	-	-	-
Butanoic acid, 4-hydroxy-	C4H8O3	2.84	-	-	-
Methyltartronic acid	C4H6O5	0.45	0.44	0.44	0.69
Lactic acid; Propanoic acid, 2-hydroxy-, ethyl ester	C5H10O3	-	-	-	-
Pentanoic acid, 4-oxo-	C5H8O3	-	-	1.07	0.34
Pentanoic acid, 4-oxo-, ethyl ester	C7H12O3	0.15	-	-	-
Butanoic acid, anhydride	C8H14O3	5.00	3.87	4.39	4.61
Propanoic acid, 2-methyl-, anhydride	C8H14O3	0.17	-	0.78	-
Pentanoic acid, 4-oxo-, 2-methylpropyl ester	C9H16O3	0.32	-	0.22	-
Dodecanoic acid, methyl ester	C13H26O2	1.93	1.92	2.49	2.15
Pentanoic acid, 2-methyl-4-oxo-		-	-	-	-
alcohol		***0.40***	***0.83***	***1.06***	***0.35***
1,3-Propanediol	C3H8O2	0.23	0.20	0.22	0.19
Ethanol, 2,2'-oxybis-	C4H10O3	-	-	-	-
1,2-Propanediol, 3-methoxy-	C4H10O3	0.17	0.16	0.16	0.16
1-Propanol, 2-(2-hydroxypropoxy)-	C6H14O3	-	0.47	0.67	-
Glycerol derived		***8.07***	***6.53***	***6.56***	***0.72***
3-Ethoxy-1,2-propanediol; Glycerol 1-ethyl ether	C5H12O3	0.14	-	0.13	-
Glycerol triethyl ether	C9H20O3	-	0.21	-	-
1,3-Dioxolane-4-methanol, 2-ethyl-	C6H12O3	0.86	1.00	1.33	0.20
Glycerin	C3H8O3	2.17	-	-	-
1,2,3-Propanetriol, 1-acetate	C5H10O4	-	1.25	-	-
Glycerol 1,2-diacetate	C7H12O5	-	-	-	0.52
Alpha-monopropionin	C6H12O4	-	0.15	-	-
Hydroxyacetone; 2-Propanone, 1-hydroxy-	C3H6O2	-	-	0.81	-
2,3-dihydroxypropyl isobutyrate	C7H14O4	4.89	3.92	4.29	-
Total		***91.23***	***92.56***	***86.49***	***73.17***

< 참나무 껍질O depolymerization 350 °C, Gly 10%, 30 min >

(area%)

Groups		No cat	Pt/C	Ru/C	Raney Ni
Syringyl		***25.78***	***26.00***	***30.9***	***29.29***
Phenol, 2,6-dimethoxy-	C8H10O3	14.33	12.33	17.20	16.23
4-methylsyringol; 3,5-Dimethoxy-4-hydroxytoluene	C9H12O3	5.13	6.71	6.41	6.51
4-Ethylsyringol; 4-Ethyl-2,6-dimethoxyphenol	C10H14O3	2.31	2.96	2.82	3.02
4-Propylsyringol; 2,6-Dimethoxy-4-propylphenol	C11H16O3	1.03	1.68	1.22	1.25
(E)-4-Propenylsyringol; (E)-2,6-Dimethoxy-4-(prop-1-en-1- yl)phenol	C11H14O3	0.44	0.57	0.51	0.45
4-Acetylsyringol; Acetosyringon; Ethanone, 1-(4-hydroxy-3,5- dimethoxyphenyl)-	C10H12O4	0.61	0.45	0.74	0.46
Syringylacetone	C11H14O4	1.52	1.06	1.76	1.17
Propiosyringone; 1-Propanone, 1-(4-hydroxy-3,5-dimethoxyphenyl)-	C11H14O4	0.19	0.24	-	-
Dihydrosyringenin; 3-Syringylpropanol	C11H16O4	0.22	-	0.24	0.20
Guaiacyl		***24.75***	***24.43***	***28.6***	***27.83***
Guaiacol; Phenol, 2-methoxy-	C7H8O2	10.78	10.42	12.54	12.87
5-Methylguaiacol; m-Creosol; 2-Methoxy-5-methylphenol	C8H10O2	4.80	6.66	5.30	5.80
4-Ethylguaiacol; Phenol, 4-ethyl-2-methoxy-	C9H12O2	3.53	4.41	3.74	4.50
4-Propylguaiacol; Phenol, 2-methoxy-4-propyl-	C10H14O2	1.16	1.99	1.45	1.74
Benzaldehyde, 3-hydroxy-4-methoxy-	C8H8O3	-	0.29	0.80	0.58
Allylguaiacol; Eugenol	C10H12O2	0.30	-	0.42	-
Guaiacylacetone; 2-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-	C10H12O3	2.99	-	3.28	2.34
4-(2-Hydroxyethyl)guaiacol; Homovanillyl alcohol	C9H12O3	0.31	-	-	-
3-(4-guaiacyl)propanol; Benzenepropanol, 4-hydroxy-3- methoxy-	C10H14O3	0.88	0.67	1.07	-
Poly aromatics		***2.59***	***1.89***	***3.34***	***3.43***
Naphthalene	C10H8	0.25	-	0.18	0.23
2-Naphthalenol, 3-methoxy-	C11H10O2	0.77	0.50	1.05	0.76
1,6-Dimethoxynaphthalene	C12H12O2	0.32	0.16	0.46	0.33
Naphthalene, 2,3-dimethoxy-	C12H12O2	0.39	0.30	0.60	0.62
Retene	C18H18	-	0.34	-	0.86
2-Isopropyl-10-methylphenanthrene	C18H18	0.43	0.33	0.58	-
Methyl dehydroabietate	C21H30O2	0.28	0.25	0.47	0.46
8-Isopropyl-1,3-dimethylphenanthrene	C19H20	0.16	-	-	0.17
Other aromatics		***21.71***	***21.71***	***22.75***	***22.03***
Phenol	C6H6O	0.57	0.46	0.90	0.76
o-Cresol; Phenol, 2-methyl-	C7H8O	0.31	0.23	0.55	0.48
Catechol	C6H6O2	2.90	2.64	4.02	3.53
2-Acetyl-4-methylphenol; o-Acetyl-p-cresol	C9H10O2	0.16	-	-	-
3-methoxycatechol; 1,2-Benzenediol, 3-methoxy-	C7H8O3	5.94	5.63	7.55	7.05
Hydroquinone	C6H6O2	-	0.16	-	-
4-Methylcatechol; 1,2-Benzenediol, 4-methyl-	C7H8O2	1.24	1.32	1.29	1.53
Phenol, 3,4-dimethoxy-	C8H10O3	1.58	1.81	1.90	1.25
5-Methoxy-m-cresol; 3-Methoxy-5-methylphenol	C8H10O2	0.16	0.20	-	-
1,4-Benzenedicarboxaldehyde, 2-methyl- ; 2-Methylterephthalaldehyde	C9H8O2	-	0.14	-	-
Ethanone, 1-(2-hydroxy-6-methoxyphenyl)-	C9H10O3	-	0.13	-	-
1,2,3-Trimethoxybenzene	C9H12O3	1.11	0.92	1.26	1.12
4-Ethylcatechol	C8H10O2	0.43	0.52	0.67	1.09
1,4-Benzenediol, 2,3,5-trimethyl- ; Trimethylhydroquinone	C9H12O2	-	0.13	-	-
Ethanone, 1-(2,3,4-trihydroxyphenyl)-	C8H8O4	-	0.23	0.30	0.85
Vanillin	C8H8O3	0.72	-	-	-
3-Ethoxy-4-methoxyphenol	C9H12O3	0.18	-	-	-
3-Acetylphenol; Ethanone, 1-(3-hydroxyphenyl)-	C8H8O2	0.15	-	0.35	0.14
Apocynin	C9H10O3	1.05	0.89	1.32	1.01
Benzene, 1,2,3-trimethoxy-5-methyl-	C10H14O3	0.26	0.23	0.28	0.23
2-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-	C10H12O3	-	2.66	-	-
Flopropione	C9H10O4	-	0.44	0.29	0.37
3,4-Dimethoxyphenylacetone	C11H14O3	0.15	-		
1-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-	C10H12O3	0.14	0.26	-	-
Butyrovanillone	C11H14O3	0.15	0.13	0.16	0.18
Phenol, 2-methoxy-4-methyl-6-[propenyl]-	C11H14O2	0.17	-	-	0.26
2,3-Dimethoxy-5-aminocinnamonitrile	C11H12N2O2	0.20	0.13	-	-
3,4-Divanillyltetrahydrofuran	C20H24O5	1.56	0.14	-	-
1-(2,4-Dihydroxyphenyl)-2-(3,4-dimethoxyphenyl) ethanone	C16H16O5	0.23	0.43	-	0.24
1-(2,4-Dihydroxyphenyl)-2-(3,5-	C17H18O5	-	0.32	-	-
Dehydroabietate	C20H28O2	2.38	1.54	-	-
3,4-Dimethoxyphenol, 2- methylpropionate	C12H16O4	-	-	1.91	1.94
Alkanes(Paraffins)		***1.08***	***0.88***	***0.00***	***0.00***
Propane, 1,1-diethoxy-	C7H16O2	1.08	0.75	-	-
Propanal ethyl isopentyl acetal; 1-(1-Ethoxypropoxy)-3-methylbutane	C10H22O2	-	0.13	-	-
Cyclic		***2.16***	***2.05***	***2.55***	***1.76***
Oxazolidin-2-one	C3H5NO2	-	0.20	-	-
Butyrolactone	C4H6O2	2.01	1.47	2.11	1.38
2-Cyclopenten-1-one, 3-methyl-	C6H8O	-	0.19	0.19	0.18
2-Cyclopenten-1-one, 2,3-dimethyl-	C7H10O	0.16	0.19	0.25	0.20
Fatty Acids		***2.70***	***5.25***	***0.67***	***2.78***
Propanoic acid	C3H6O2	-	0.38	0.23	0.29
Lactic acid; Propanoic acid, 2-hydroxy-, ethyl ester	C5H10O3	0.36	0.14	-	-
Pentanoic acid, 4-oxo-	C5H8O3	0.79	-	-	-
Pentanoic acid, 4-oxo-, ethyl ester	C7H12O3	-	0.15	-	-
Butanoic acid, anhydride	C8H14O3	-	3.16	-	0.18
Dodecanoic acid, methyl ester	C13H26O2	1.55	1.41	-	2.09
Methyltartronic acid	C4H6O5	-	-	0.23	0.22
Pentanoic acid, 2-methyl-4-oxo-	C6H10O3	-	-	0.21	-
alcohol		***0.28***	***1.10***	***0.95***	***1.01***
1,3-Propanediol	C3H8O2	-	0.13	-	-
Ethanol, 2,2'-oxybis-	C4H10O3	-	0.25	-	-
1,2-Propanediol, 3-methoxy-	C4H10O3	0.28	0.32	0.42	0.51
1-Propanol, 2-(2-hydroxypropoxy)-	C6H14O3	-	0.39	0.53	0.50
Glycerol derived		***5.06***	***6.72***	***1.24***	***0.89***
Glycerol triethyl ether	C9H20O3	-	0.16	-	-
1,3-Dioxolane-4-methanol, 2-ethyl-	C6H12O3	0.58	0.86	0.93	0.89
1,2,3-Propanetriol, 1-acetate	C5H10O4	0.26	2.15	0.31	-
Alpha-monopropionin	C6H12O4	-	0.38	-	-
Hydroxyacetone; 2-Propanone, 1-hydroxy-	C3H6O2	0.65	-	-	-
2,3-dihydroxypropyl isobutyrate	C7H14O4	3.58	3.17	-	-
Total		***86.11***	***90.01***	***90.33***	***89.02***

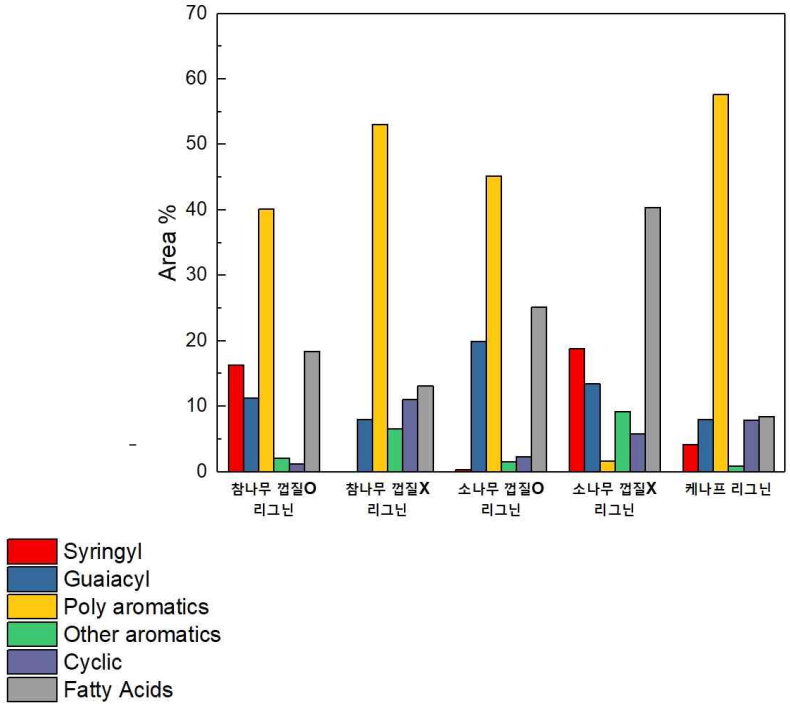
< 참나무 껍질O depolymerization 400 °C, Gly 10%, 30 min >

(area%)

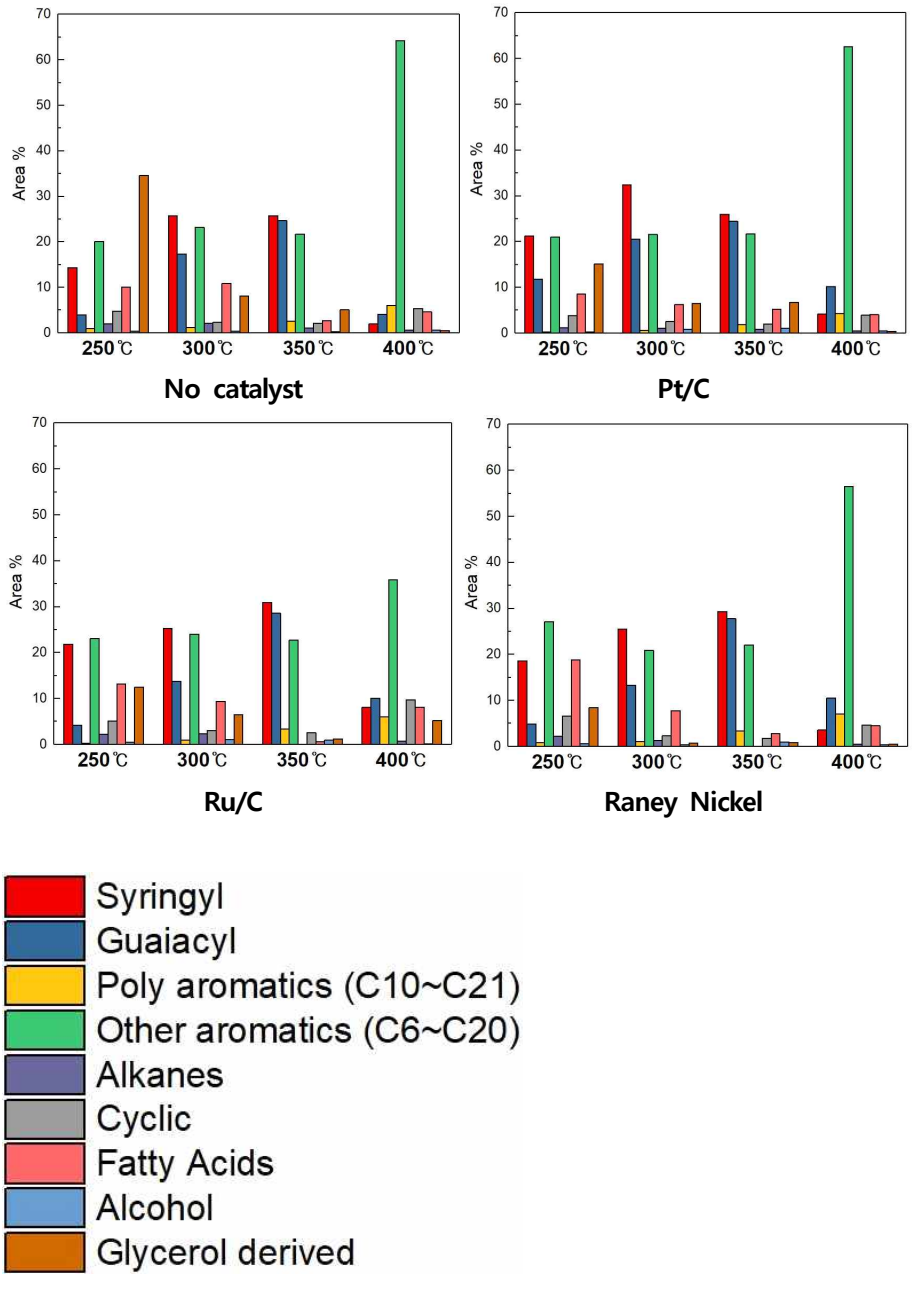
Groups		No cat	Pt/C	Ru/C	Raney Ni
Syringyl		***1.98***	***4.20***	***8.09***	***3.56***
Phenol, 2,6-dimethoxy-	C8H10O3	-	4.08	5.58	3.56
4-methylsyringol; 3,5-Dimethoxy-4-hydroxytoluene	C9H12O3	1.76	-	2.51	-
2,6-Dimethoxytoluene	C9H12O2	0.22	0.12	-	-
Guaiacyl		***4.11***	***10.2***	***10.11***	***10.51***
Guaiacol; Phenol, 2-methoxy-	C7H8O2	-	4.87	4.11	4.43
5-Methylguaiacol; m-Creosol; 2-Methoxy-5-methylphenol	C8H10O2	1.60	3.09	2.17	2.25
4-Ethylguaiacol; Phenol, 4-ethyl-2-methoxy-	C9H12O2	2.51	2.24	3.83	1.57
Creosol	C8H10O2	-	-	-	2.26
Poly aromatics		***6.02***	***4.31***	***6.06***	***7.08***
Naphthalene	C10H8	-	-	0.49	0.10
Retene	C18H18	3.21	2.74	2.09	3.51
Methyl dehydroabietate	C21H30O2	0.14	0.24	-	0.19
8-Isopropyl-1,3-dimethylphenanthrene	C19H20	0.72	0.65	0.59	0.81
13-isopropyl-, methyl ester	C20H28O2	1.30	-	2.89	1.77
18-Norabieta-8,11,13-triene	C19H28	0.65	0.68	-	0.70
Other aromatics		***64.22***	***62.65***	***35.87***	***56.5***
Phenol	C6H6O	0.92	0.72	2.30	0.90
o-Cresol; Phenol, 2-methyl-	C7H8O	1.38	0.84	2.07	1.38
Catechol	C6H6O2	7.79	10.38	5.77	6.98
3-methoxycatechol; 1,2-Benzenediol, 3-methoxy-	C7H8O3	3.64	5.58	3.75	4.74
Hydroquinone	C6H6O2	-	0.65	0.45	-
4-Methylcatechol; 1,2-Benzenediol, 4-methyl-	C7H8O2	8.44	11.13	-	8.38
Phenol, 3,4-dimethoxy-	C8H10O3	1.32	2.85	-	1.75
5-Methoxy-m-cresol; 3-Methoxy-5-methylphenol	C8H10O2	0.28	0.49	-	0.27
Ethanone, 1-(2-hydroxy-6-methoxyphenyl)-	C9H10O3	-	0.15	0.16	-
4-Ethylcatechol	C8H10O2	4.41	5.33	2.37	4.00
1,4-Benzenediol, 2,3,5-trimethyl- ; Trimethylhydroquinone	C9H12O2	3.78	-	-	3.05
3-Acetylphenol; Ethanone, 1-(3-hydroxyphenyl)-	C8H8O2	0.14	-	-	-
Guaiacylacetone; 2-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-	C10H12O3	-	-	-	0.95
3,4-Dimethoxyphenol, 2-methylpropionate	C12H16O4	1.69	-	3.20	2.11
p-Cresol	C7H8O	0.68	-	-	-
p-Guaiacol; Mequinol	C7H8O2	3.26	-	-	-
Phenol, 2,4-dimethyl-	C8H10O	0.88	0.61	0.77	0.82
Pyrocatechol; 1,2-Benzenediol, 3-methyl-	C7H8O2	6.40	4.67	3.86	5.57
2,5-dimethylresorcinol; 1,3-Benzenediol, 2,5-dimethyl-	C8H10O2	3.69	4.83	-	2.79
Resorcinol, 4,5-dimethyl; 1,3-Benzenediol, 4,5-dimethyl-	C8H10O2	6.23	1.76	-	5.30
4-Methoxy-2,6-dimethylphenol	C9H12O2	1.91	1.39	-	1.61
p-Ethylguaiacol; Phenol, 4-ethyl-2-methoxy-	C9H12O2	2.51	2.24	3.83	1.57
Resorcinol, 2-acetyl-	C8H8O3	0.69	-	-	-
2-Acetyl-7-hydroxybenzofuran	C10H8O3	0.72	-	-	-
1,4-Benzenedicarboxaldehyde, 2,5-dimethyl-	C10H10O2	-	1.61	-	-
4-propylresorcinol; 1,3-Benzenediol, 4-propyl-	C9H12O2	0.48	2.22	-	1.31
Benzofuran, 5-methoxy-6,7-dimethyl-	C11H12O2	0.51	0.51	-	-
3,4-dihydroxyphenyl-2-propanone	C9H10O3	-	0.64	-	-
3,4'-Diisopropylbiphenyl	C18H22	-	0.65	-	0.54
Dehydroabietate; Dehydroabietic acid	C20H28O2	-	1.47	-	-
Phenol, 2-ethyl-	C8H10O	0.31	0.17	0.56	0.32
o-Acetyl-p-cresol; Ethanone, 1-(2-hydroxy-5-methylphenyl)-	C9H10O2	-	-	0.53	-
o-Xylene-3,6-diol; 2,3-Dimethylhydroquinone	C8H10O2	-	-	4.65	-
3-Isopropyl-1,2-benzenediol	C9H12O2	-	-	1.60	2.16
Alkanes(Paraffins)		1.08	0.88	0.00	0.00
Propane, 1,1-diethoxy-	C7H16O2	1.08	0.75	-	-
Propanal ethyl isopentyl acetal; 1-(1-Ethoxypropoxy)-3-methylbutane	C10H22O2	-	0.13	-	-
Alkanes(Paraffins)		***0.58***	***0.53***	***0.73***	***0.45***
Heneicosane	C21H44	0.26	-	-	-
Pentadecane, 2,6,10-trimethyl-	C18H38	0.16	0.14	-	-
Tetracosane	C24H50	0.16	-	-	-
Heptadecane, 2,6,10,15-tetramethyl-	C21H44	-	0.25	-	-
Pentadecane, 2,6,10-trimethyl-	C18H38	-	0.14	-	-
Ethanol, 2,2'-oxybis-	C4H10O3	-	-	0.21	-
Methylal	C3H8O2	-	-	0.19	-
Nonane, 2-methyl-5-propyl-	C13H28	-	-	0.18	-
Decane, 2,3,7-trimethyl-	C13H28	-	-	0.15	-
Nonane, 3-methyl-5-propyl-	C13H28	-	-	-	0.28
Nonadecane	C19H40	-	-	-	0.17
Cyclic		***5.38***	***3.93***	***9.78***	***4.66***
Trimethylene oxide	-	-	-	0.19	-
2-Cyclopenten-1-one, 2-methyl-	-	0.20	0.16	-	0.14
Butyrolactone	C4H6O2	1.40	1.44	3.82	1.56
2(3H)-Furanone, dihydro-5-methyl-	C5H8O2	0.13	-	0.26	0.13
2-Cyclopenten-1-one, 3-methyl-	C6H8O	0.75	0.76	0.60	0.57
2-Cyclopenten-1-one, 3,4-dimethyl-	C7H10O	0.27	0.17	-	0.17
2-Cyclopenten-1-one, 2,3-dimethyl-	C7H10O	1.22		0.94	0.98
2-Cyclopenten-1-one, 3,4,5-trimethyl-	C8H12O	0.34	0.19	0.46	0.29
2-Cyclopenten-1-one, 2,3,4-trimethyl-	C8H12O	0.54	0.40	0.73	0.48
5-Ethyl-2-furaldehyde	C7H8O2	0.09	-	0.42	-
2-Ethyl-3-methylcyclopent-2-en-1-one	C8H12O	0.44	0.30	-	0.34
2,2'-Isopropylidenedifuran	C11H12O2	-	0.51	-	-
2-Cyclopenten-1-one, 2-hydroxy-3-methyl-	C6H8O2	-	-	0.58	-
2-Acetyl-5-methylfuran	C7H8O2	-	-	0.11	-
2(3H)-Furanone, dihydro-3-methyl-	C5H8O2	-	-	0.25	-
2-Cyclopenten-1-one, 2-hydroxy-3,4-dimethyl-	C7H10O2	-	-	0.18	-
2-Oxepanone	C6H10O2	-	-	0.54	-
3,3-Dimethylcyclohexanone	C8H14O	-	-	0.47	-
2-Chloroethyl benzoate	C9H9ClO2	-	-	0.23	-
Fatty Acids		***4.67***	***4.06***	***8.13***	***4.51***

Propanoic acid	C3H6O2	0.37	0.44	0.52	0.39
Pentanoic acid, 4-oxo-, ethyl ester	C7H12O3	0.19	0.16	0.23	0.20
Dodecanoic acid, methyl ester	C13H26O2	1.47	1.21	2.58	1.55
Methyltartronic acid	C4H6O5	-	-	0.15	-
Pentanoic acid, 2-methyl-4-oxo-	C6H10O3	-	-	0.89	-
Nonanoic acid	C9H18O2	0.64	0.35	0.35	-
Octanoic acid	C8H16O2	0.59	0.35	0.42	0.52
n-Hexadecanoic acid	C16H32O2	0.57	0.82	0.70	0.80
Butanoic acid	C4H8O2	0.34	0.22	0.99	0.37
Pentanoic acid	C5H10O2	-	-	0.73	0.24
2,5-Hexanedione	C6H10O2	0.50	0.51	0.57	0.44
alcohol		***0.65***	***0.48***	***0.21***	***0.41***
Propylene Glycol	C3H8O2	0.31	0.24	0.21	0.16
1,2-Propanediol, 3-methoxy-	C4H10O3	0.34	0.24	-	0.25
Glycerol derived		***0.46***	***0.43***	***5.24***	***0.51***
1,3-Dioxolane-4-methanol, 2-ethyl-	C6H12O3	0.46	0.43	5.24	0.51
Total		***88.07***	***90.79***	***84.22***	***88.19***

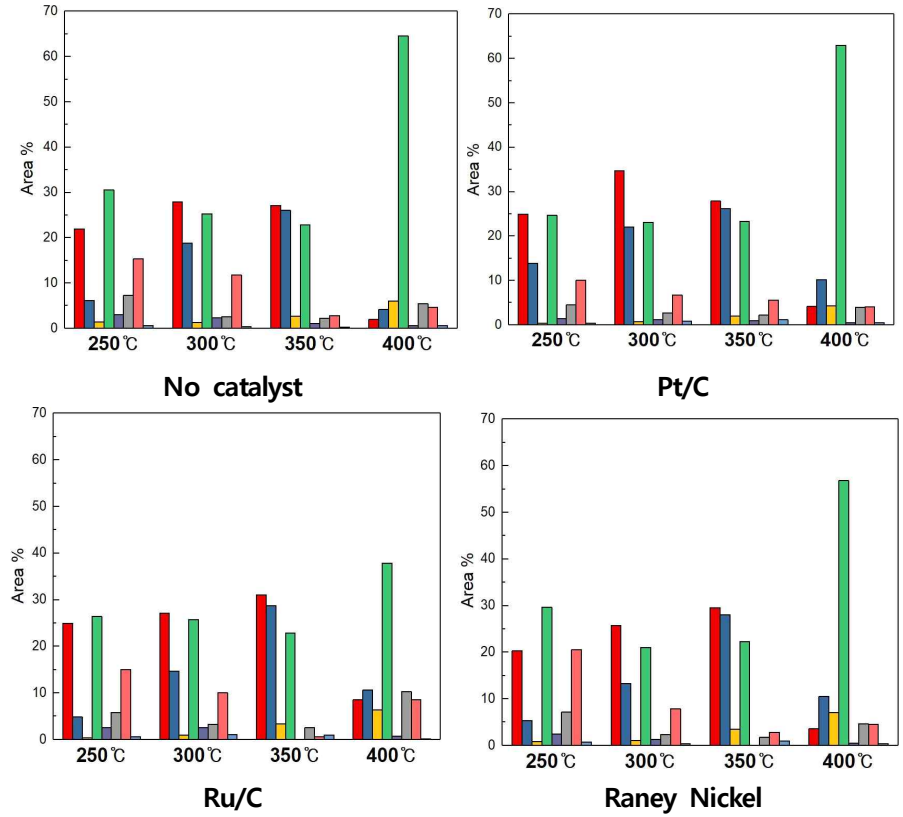
- Lignin GC-MS(정성) 결과

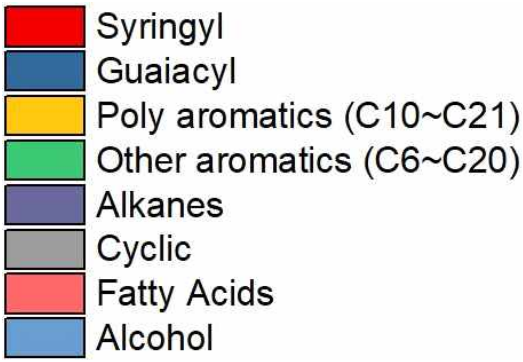


- 촉매, 온도별 GC-MS(정성) 결과 with glycerol derived



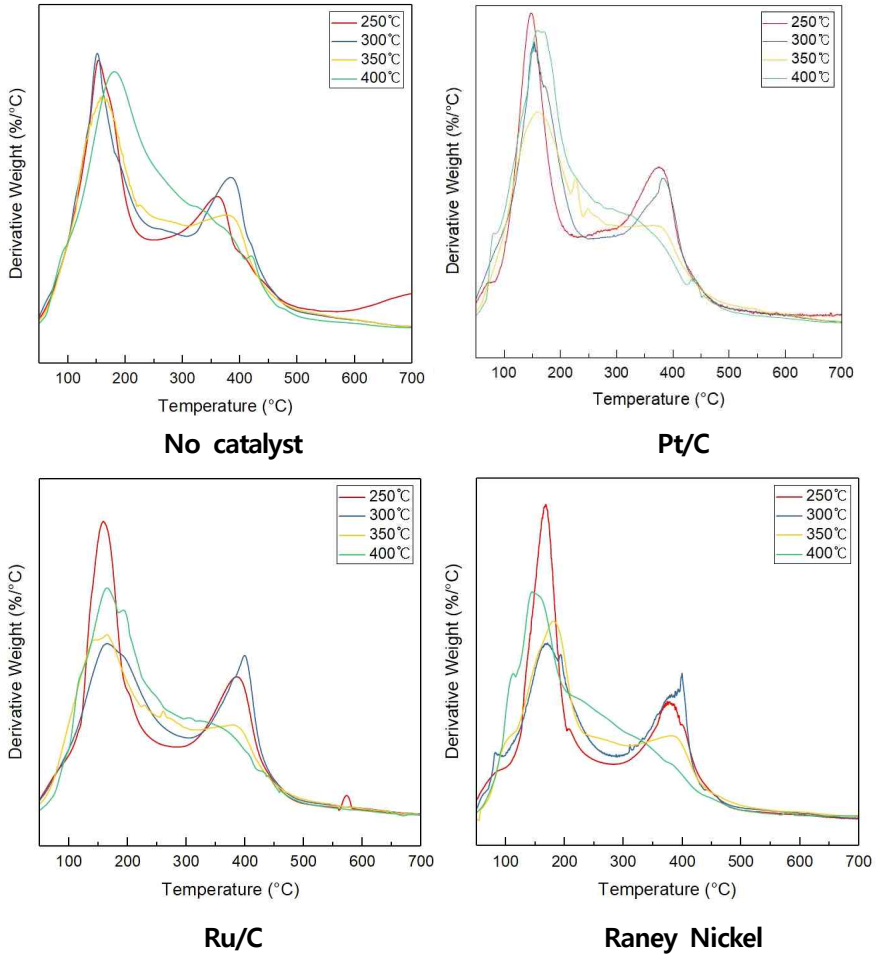
- 촉매, 온도별 GC-MS(정성) 결과 without glycerol derived



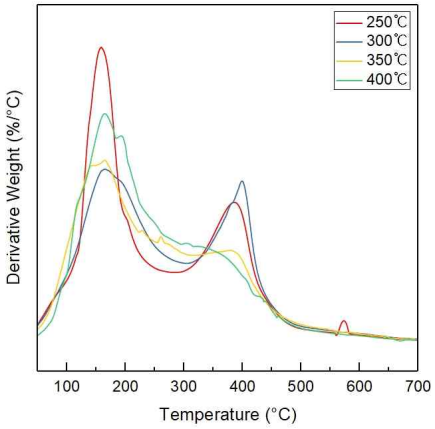


- GC-MS(정량)
- EA
- TGA

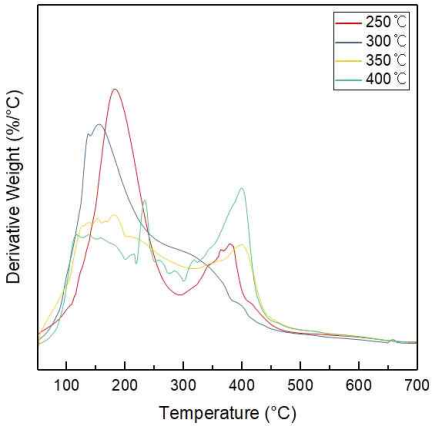
1. 참나무(껍질0) 리그닌 - 촉매, 온도별 조건



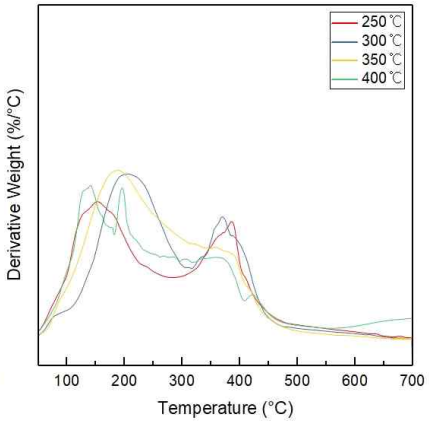
2. 4종 리그닌 - 리그닌별 온도 조건



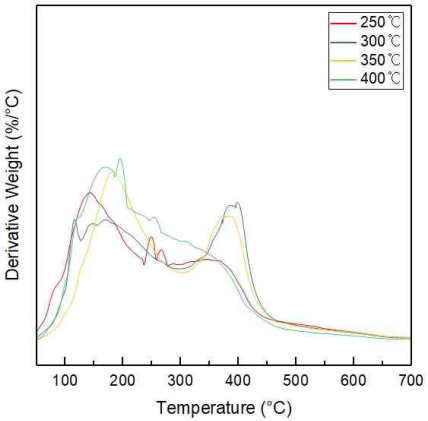
참나무 껍질O 리그닌



참나무 껍질X 리그닌

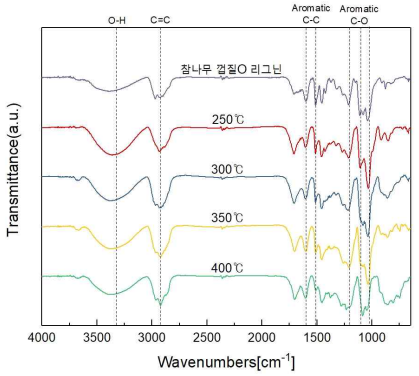


소나무 껍질O 리그닌

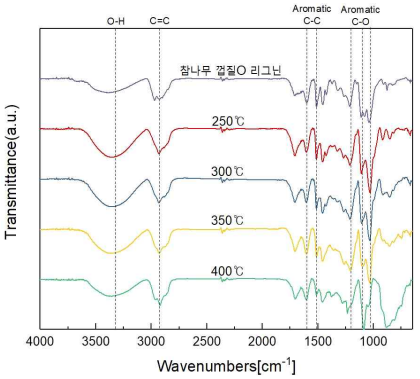


소나무 껍질X 리그닌

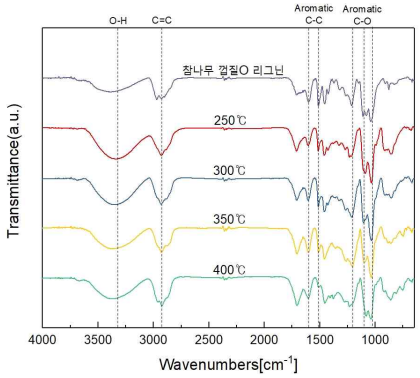
■ FTIR



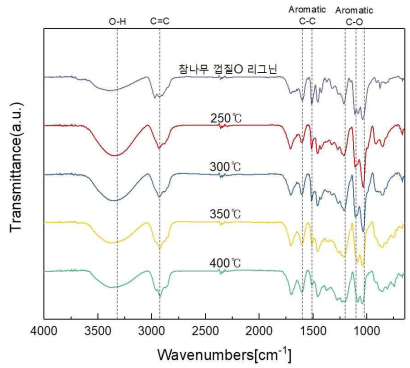
No catalyst



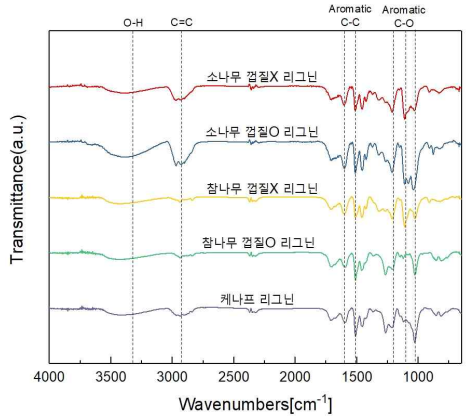
Pt/C



Ru/C



Raney Nickel



리그닌