

## REFERENCES

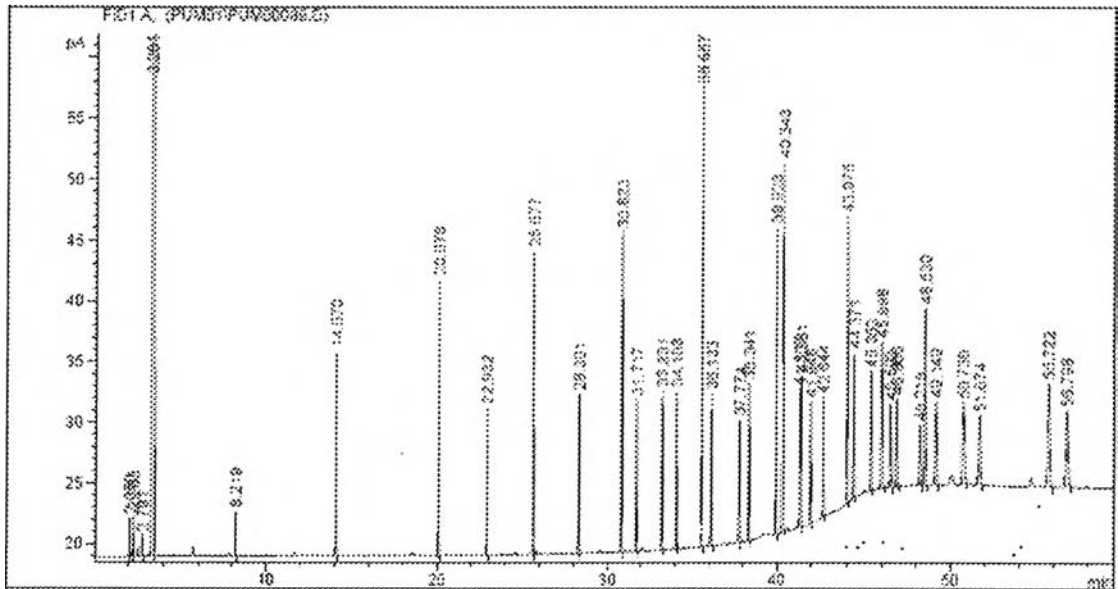
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## APPENDICES

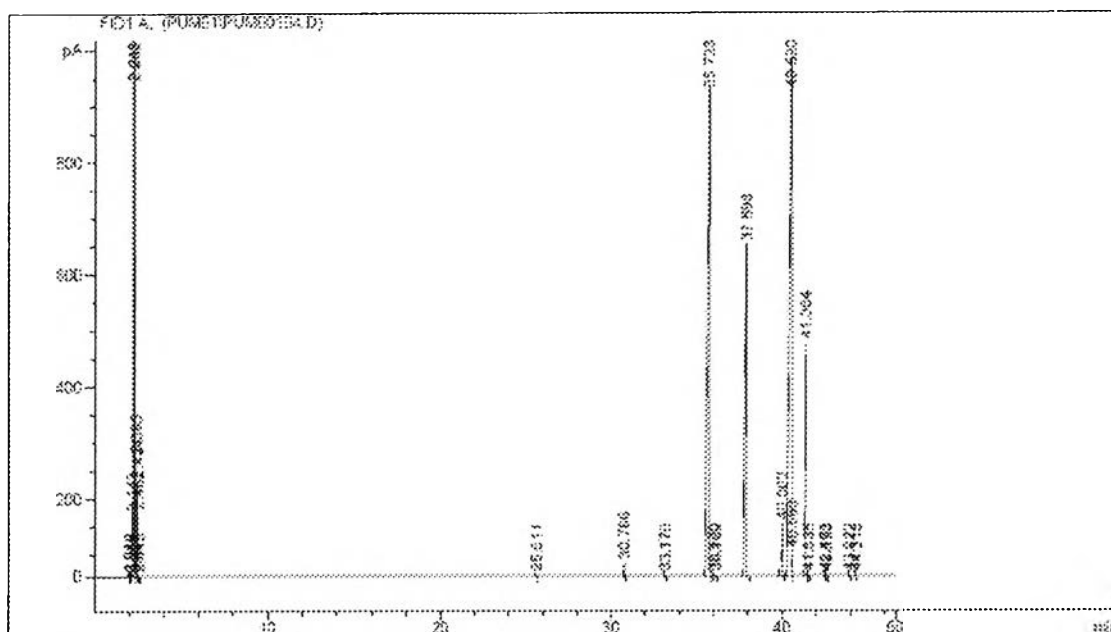
### Appendix A GC Chromatograms of Samples



**Figure A1** Standard FAME mixture

Peak #	RetTime,type [min]	Width [min]	Area [pA*s]	Height [pA]	Area %	Component (acid methyl esters)
1	2.050 BP	0.0167	3.44032	3.15493	0.01084	solvent
2	2.263 PB	0.0177	3.71842	3.41026	0.01172	solvent
3	2.791 PB	0.0205	2.25601	1.69846	0.00711	solvent
4	3.261 PB S	0.0473	3.01E+04	8720.149	94.85093	solvent
5	8.219 BP	0.0357	8.30402	3.63209	0.02617	C6:0
6	14.070 BB	0.0414	43.61553	16.75408	0.13745	C8:0
7	20.076 BB	0.0443	62.87737	22.70736	0.19816	C10:0
8	22.932 BB	0.0442	33.55172	12.14666	0.10574	C11:0
9	25.677 BP	0.045	70.69912	24.96466	0.22281	C12:0
10	28.301 BP	0.0427	36.53164	13.04093	0.11513	C13:0
11	30.823 BB	0.0444	75.33545	26.29091	0.23742	C14:0
12	31.717 BP	0.0464	36.8712	12.50433	0.1162	C14:1
13	33.231 BP	0.0476	38.7361	13.05332	0.12208	C15:0
14	34.103 BP	0.0452	38.01114	12.94865	0.11979	C15:1
15	35.557 BB	0.0468	122.0738	40.9269	0.38471	C16:0
16	36.133 BB	0.0493	38.88053	12.48299	0.12253	C16:1
17	37.774 BP	0.0474	30.51665	10.06327	0.09617	C17:0
18	38.341 BP	0.0467	38.79707	13.03176	0.12227	C17:1

Peak #	RetTime,type [min]	Width [min]	Area [pA*s]	Height [pA]	Area %	Component (acid methyl esters)
19	39.923 BB	0.0507	79.50552	25.2997	0.25056	C18:0
20	40.343 BB	0.0593	125.8197	30.40477	0.39652	C18:1n9c, C18:1n9t
21	41.307 BV	0.0497	36.50553	11.28567	0.11505	C18:2n6c
22	41.381 VB	0.0475	37.59945	12.37269	0.11849	C18:2n6t
23	41.948 BB	0.0494	31.21031	10.00486	0.09836	C18:3n6
24	42.644 BP	0.0497	30.8878	9.80706	0.09734	C18:3n3
25	43.975 BP	0.0502	77.18147	23.55087	0.24323	C20:0
26	44.371 BB	0.0503	38.41138	12.02323	0.12105	C20:1n9
27	45.353 BB	0.0533	34.74894	9.82084	0.10951	C20:2
28	45.998 PB	0.0782	67.40209	12.06854	0.21241	C20:3n6
29	46.502 BP	0.0603	27.24771	6.86504	0.08587	C20:3n3
30	46.866 BP	0.0642	29.28161	7.2305	0.09228	C20:4n6
31	48.218 BP	0.0683	22.83948	4.90321	0.07198	C20:5n3
32	48.530 BP	0.0707	71.91687	14.53911	0.22664	C22:0
33	49.149 BP	0.0829	35.9828	6.78629	0.1134	C22:1n9
34	50.736 BB	0.1024	48.49194	6.62637	0.15282	C22:2
35	51.674 BP	0.0965	35.19561	5.66533	0.11092	C23:0
36	55.722 BP	0.1002	68.32362	8.37649	0.21532	C24:0
37	56.798 BB	0.1016	51.10231	6.17416	0.16105	C22:6n3, C24:1n9



**Figure A2** Biodiesel synthesized from the optimum condition

Peak #	RetTime,type [min]	Width [min]	Area [pA*s]	Height [pA]	Area %	Component (acid methyl esters)
1	1.982 BV	0.0174	2.80886	2.26864	0.00133	solvent
2	2.046 VV	0.0254	46.53998	25.39823	0.02208	solvent
3	2.143 VV	0.0219	221.8958	153.251	0.10526	solvent
4	2.215 VV S	0.0337	1.66E+05	8.20E+04	78.87931	solvent
5	2.262 VB S	0.0194	1.92E+04	1.65E+04	9.12418	solvent
6	2.337 BV X	0.0179	3.44764	3.21879	0.00164	solvent
7	2.395 VV T	0.0235	377.3853	252.2175	0.17901	solvent
8	2.434 VV T	0.0245	351.4888	210.0655	0.16673	solvent
9	2.482 VV X	0.0219	235.8849	154.1003	0.11189	solvent
10	2.545 VB X	0.0188	19.42083	15.2965	0.00921	solvent
11	25.611 BB	0.0469	53.7684	17.96825	0.02551	C12:0
12	30.766 BB	0.05	211.7199	64.92688	0.10043	C14:0
13	33.170 BB	0.0538	8.73664	2.43983	0.00414	C15:0
14	35.723 BP	0.1069	7777.512	917.5122	3.68929	C16:0
15	36.109 VB	0.0453	35.34119	12.02345	0.01676	C16:1
16	37.898 BB	0.0844	4290.582	630.5085	2.03525	C17:0
17	40.002 BP	0.0838	844.4799	133.4981	0.40058	C18:0
18	40.520 BV	0.1083	8324.809	977.8036	3.94891	C18:1n9c
19	40.560 VB	0.0239	128.0394	83.39816	0.06074	C18:1n9t
20	41.364 BV	0.0658	2173.329	454.7363	1.03093	C18:2n6c
21	41.535 VB	0.0476	22.80376	7.2651	0.01082	C18:2n6t

Peak #	RetTime,type [min]	Width [min]	Area [pA*s]	Height [pA]	Area %	Component (acid methyl esters)
22	42.473 BV	0.0497	6.55542	2.03038	0.00311	C18:3n6
23	42.593 VP	0.0462	43.14594	13.53609	0.02047	C18:3n3
24	43.922 BB	0.0548	74.06207	19.74046	0.03513	C20:0
25	44.315 BB	0.0551	29.50941	8.16842	0.014	C20:1n9

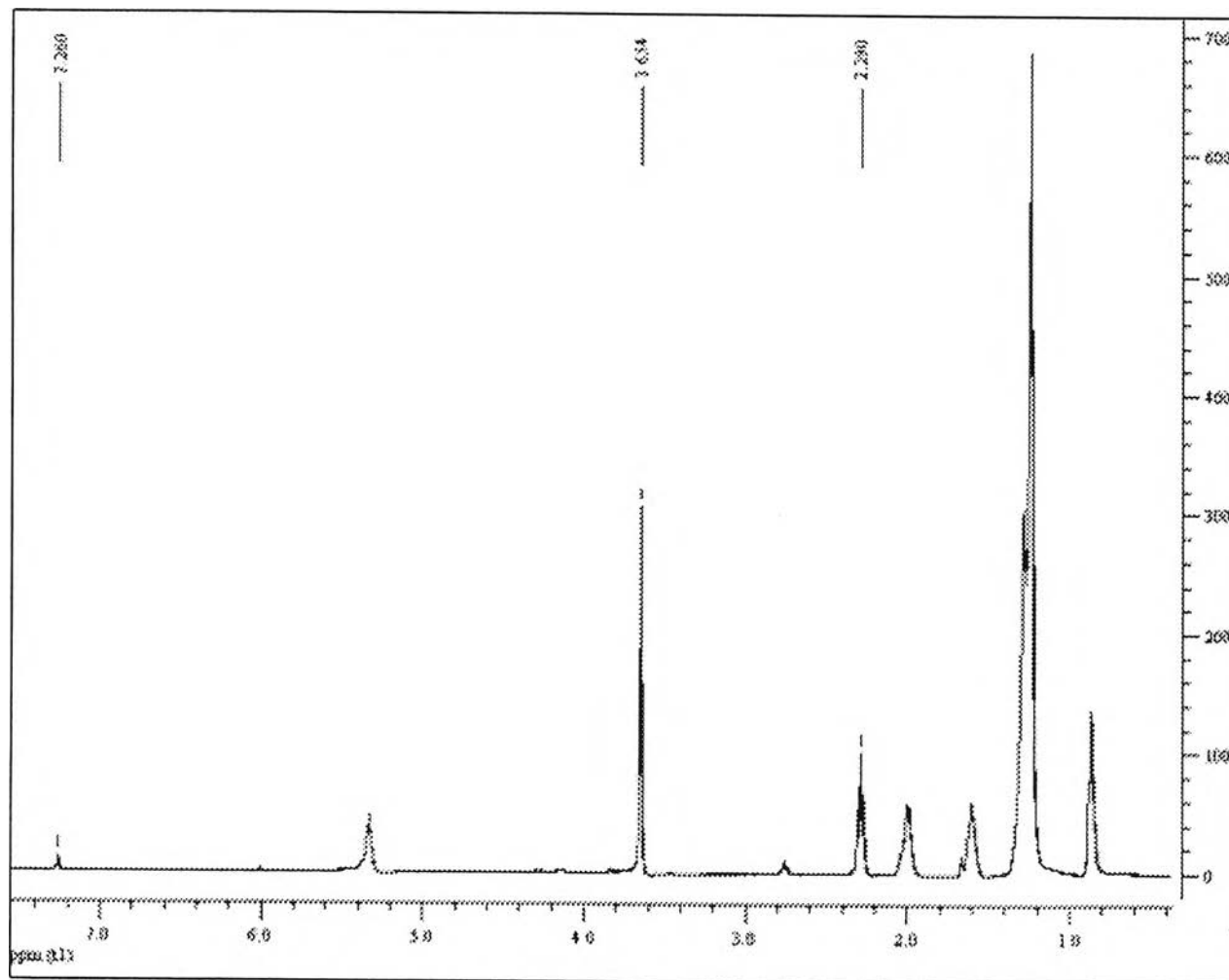
### Appendix B SEM-EDS of pure zirconia and 1%NaOH/ZrO<sub>2</sub>

Sample	Element	%Element
ZrO <sub>2</sub>	O	17.06
	Na	0.00
	Zr	27.52
Fresh 1%NaOH in methanol/ZrO <sub>2</sub>	O	35.91
	Na	7.69
	Zr	43.48
Used 1%NaOH in methanol/ZrO <sub>2</sub>	O	40.72
	Na	5.66
	Zr	53.62

### Appendix C Kinematic Viscosity at 40°C of biodiesel

No.	Time (s)	Viscosity (cSt)
1	317.00	4.54578
2	316.75	4.542195
<b>Average</b>	316.875	4.543988



Appendix D  $^1\text{H}$ -NMR spectrum of sample at optimum condition

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Longloilert, R., Wongkasemjit, S., Luengnaruemitchai, A., and Pengprecha, S. (2008, January 6-8) Factors Affecting Transesterification of Palm Oil into Biodiesel in the Presence of NaOH and ZrO<sub>2</sub>. Paper presented at MPA 2008, Cambridge, England.

