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APPENDIX A
Formation of Microemulsion

Chemicals	Molecular weight (g/mol)	Specific gravity (g/cm^3)
n-heptane	100.21	0.684
AOT	444.57	1.1
NaCl	58.44	1.197
NH_4OH	35.03	0.91
TiO_2	79.9	

A1 Phase Behavior of Microemulsion

Mass fraction of AOT (γ) = 3.0 wt%

Mass fraction of oil (α) = 50.0 wt%

Varying mass fraction of salt (ε)

AOT	n-heptane		Water	NaCl		Type of Microemulsion
g	g	mL	mL	g	wt%	
0.6192	10.01	14.6345	10	0.01	0.1	Type I (o/w)
0.6198	10.02	14.6491	10	0.02	0.2	
0.6210	10.04	14.6784	10	0.04	0.4	
0.6223	10.06	14.7076	10	0.06	0.6	
0.6242	10.10	14.7661	10	0.10	1.0	Type III (bicontinuous)
0.6272	10.14	14.8246	10	0.14	1.4	
0.6297	10.18	14.8830	10	0.18	1.8	
0.6309	10.20	14.9123	10	0.20	2.0	
0.6340	10.25	14.9854	10	0.25	2.5	Type II (w/o)
0.6359	10.28	15.0292	10	0.28	2.8	
0.6396	10.34	15.1170	10	0.34	3.4	
0.6433	10.40	15.2047	10	0.40	4.0	
0.6495	10.50	15.3509	10	0.50	5.0	
0.6557	10.60	15.4971	10	0.60	6.0	
0.6619	10.70	15.6433	10	0.70	7.0	
0.6680	10.80	15.7895	10	0.80	8.0	

Table A1.1 Dynamic light scattering data for micellar size determination.

% NaCl	Zave[1] (nm)	Poly[2]	Fit error[3]	% Merit[4]	% In range[5]
0.1	15.0	0.140	0.00206	51.5	92.0
	14.8	0.113	0.00211	51.9	97.5
	14.5	0.125	0.00140	51.8	98.0
0.2	15.1	0.133	0.00222	49.1	96.6
	15.0	0.258	0.00099	37.7	92.7
	15.5	0.237	0.00054	41.1	92.0
0.4	16.0	0.108	0.00177	50.7	98.0
	15.9	0.120	0.00135	50.6	95.3
	15.6	0.108	0.00106	50.5	97.5
0.6	17.9	0.146	0.00075	47.6	94.6
	18.4	0.229	0.00064	39.7	92.9
	18.6	0.248	0.00028	39.6	91.2
1.0	37.5	1.000	0.00123	48.1	87.9
	38.3	1.000	0.00210	39.9	87.7
	40.2	1.000	0.00141	48.0	86.7
1.4	48.8	1.000	0.00286	44.6	81.4
	39.7	1.000	0.00188	44.6	82.9
	42.2	1.000	0.00409	47.0	81.1
1.8	67.6	1.000	0.00083	43.5	87.7
	64.0	1.000	0.00074	48.1	86.8
	60.8	1.000	0.00083	44.3	88.0
2.0	81.1	1.000	0.00088	40.5	85.1
	72.0	1.000	0.00087	48.6	87.0
	88.9	1.000	0.00069	42.2	88.8
2.5	40.5	0.728	0.00424	51.3	95.0
	41.9	0.761	0.00386	51.6	94.4
	41.3	0.725	0.00399	51.8	94.6
2.8	38.3	0.628	0.00602	51.2	93.7
	38.7	0.613	0.00595	52.2	94.3
	37.8	0.571	0.00653	56.2	93.9
3.4	36.9	0.459	0.00504	55.5	96.5
	37.1	0.524	0.00446	54.8	91.9
	36.4	0.480	0.00435	57.5	98.9

Table A1.1 (cont.) Dynamic light scattering data for micellar size determination.

% NaCl	Zave[1] (nm)	Poly[2]	Fit error[3]	% Merit[4]	% In range[5]
0.4	34.5	0.464	0.00881	44.3	83.2
	34.6	0.402	0.00816	44.9	85.8
	34.9	0.464	0.00708	45.4	90.9
0.5	30.4	0.298	0.00159	45.8	89.7
	30.2	0.319	0.00170	46.2	91.3
	30.9	0.299	0.00155	45.3	87.8
0.6	26.2	0.287	0.00194	49.7	91.3
	26.4	0.287	0.00200	48.4	91.3
	26.6	0.272	0.00207	49.6	94.7
0.7	19.6	0.270	0.00253	47.6	95.4
	20.3	0.274	0.00241	47.8	91.3
	20.6	0.288	0.00247	48.2	92.4
0.8	16.4	0.243	0.00144	46.6	87.8
	17.8	0.243	0.00151	46.8	90.6
	15.6	0.248	0.00141	47.0	94.7

Note: data for Figure 4.2, 4.3 (a), and 4.4 (a)

[1] The Z average mean size result of current record. The average diameter size of particle.

[2] The polydispersity calculated using the initial cumulants fit to the current size result. If the value is close to 1.0, particle size distribution is very wide.

[3] The value calculated for the correlation coefficient as corresponding exactly to the size distribution resulting from the fitting procedure. The smaller the value, the better the fitting.

[4] Merit value for the current record. The percentage of (correlation – baseline) / baseline. Typically 10-60%. The value between 10-60, the signal to noise ratio is good.

[5] In range value calculated from the ratio of the far point. A higher value (85-100%) indicates that the correlation function has nearly decayed to 0 by the measured far point, and hence the sample time is set to a suitable value, and the experiment is well founded one. The value between 85-100, the average diameter size is the exact result.

Table A1.2 Coulometer data for determination of water. Sample volume 50 μL.

% NaCl	Amount of water (wt%)		
	1	2	3
0.1	N/A	N/A	N/A
0.2	N/A	N/A	N/A
0.4	N/A	N/A	N/A
0.6	N/A	N/A	N/A
1.0	59.89	59.77	59.46
1.4	57.02	56.29	55.99
1.8	49.21	49.06	48.94
2.0	30.02	29.96	29.45
2.5	4.650	4.614	4.866
2.8	4.473	4.281	4.292
3.4	3.952	3.950	3.901
4.0	3.747	3.823	3.711
5.0	3.521	3.567	3.563
6.0	3.414	3.357	3.425
7.0	3.390	3.283	3.280
8.0	3.129	3.182	3.106

Note: data for Figure 4.3 (b), and 4.4 (b)

Table A1.3 Summary of microemulsion data.

O/W Microemulsion			Bicontinuous Microemulsion			W/O Microemulsion		
%NaCl	Size (nm)	H_2O (%)	%NaCl	Size (nm)	H_2O (%)	%NaCl	Size (nm)	H_2O (%)
0.1	14.77±0.25	N/A	1.0	38.67±1.39	59.71±0.22	2.5	41.23±0.70	4.71±0.14
0.2	15.20±0.26	N/A	1.4	43.57±4.70	56.43±0.53	2.8	38.27±0.45	4.35±0.11
0.4	15.83±0.21	N/A	1.8	64.13±3.40	49.07±0.14	3.4	36.80±0.36	3.93±0.03
0.6	18.30±0.36	N/A	2.2	80.67±8.46	29.81±0.31	4.0	34.67±0.21	3.76±0.06
						5.0	30.50±0.36	3.55±0.33
						6.0	26.40±0.20	3.40±0.04
						7.0	20.17±0.51	3.32±0.06
						8.0	16.60±1.11	3.14±0.04

* Excess water phase

A2 Effects of $TiCl_4$ Concentration

0.1 M, 0.2 M, and 0.3 M $TiCl_4$ solution was prepared from conc. $TiCl_4$ 3.4479 M.

6.0% AOT in n-heptane (mL)	0.1 M $TiCl_4$ (mL)	NaCl		Type of Microemulsion
		g	wt%	
14.6345	10	0.01	0.1	Type I (o/w)
14.6491	10	0.02	0.2	
14.6784	10	0.04	0.4	
14.7076	10	0.06	0.6	
14.7661	10	0.10	1.0	Type III (bicontinuous)
14.8246	10	0.14	1.4	
14.8830	10	0.18	1.8	
14.9123	10	0.20	2.0	
14.9854	10	0.25	2.5	Type II (w/o)
15.0292	10	0.28	2.8	
15.1170	10	0.34	3.4	
15.2047	10	0.40	4.0	
6.0% AOT in n-heptane (mL)	**0.2 M $TiCl_4$ (mL)**	**NaCl**		**Type of Microemulsion**
		g	wt%	
14.6345	10	0.01	0.1	Type I (o/w)
14.6491	10	0.02	0.2	
14.6784	10	0.04	0.4	
14.7076	10	0.06	0.6	
14.7661	10	0.10	1.0	Type III (bicontinuous)
14.8246	10	0.14	1.4	
14.8830	10	0.18	1.8	
14.9123	10	0.20	2.0	
14.9854	10	0.25	2.5	Type II (w/o)
15.0292	10	0.28	2.8	
15.1170	10	0.34	3.4	
15.2047	10	0.40	4.0	
6.0% AOT in n-heptane (mL)	**0.3 M $TiCl_4$ (mL)**	**NaCl**		**Type of Microemulsion**
		g	wt%	
14.6345	10	0.01	0.1	Type I (o/w)
14.6491	10	0.02	0.2	
14.6784	10	0.04	0.4	
14.7076	10	0.06	0.6	
14.7661	10	0.10	1.0	Type III (bicontinuous)
14.8246	10	0.14	1.4	
14.8830	10	0.18	1.8	
14.9123	10	0.20	2.0	
14.9854	10	0.25	2.5	Type II (w/o)
15.0292	10	0.28	2.8	
15.1170	10	0.34	3.4	
15.2047	10	0.40	4.0	

A2.1 Dynamic Light Scattering Data

Table A2.1.1 Dynamic light scattering data of o/w microemulsion.

$TiCl_4$ (M)	% NaCl	Zave	Poly	Fit error	% Merit	% In range
0.0	0.1	150.5	0.140	0.00206	51.5	92.0
		148.2	0.113	0.00211	51.9	97.5
		148.8	0.125	0.00140	51.8	98.0
	0.2	260.3	0.133	0.00222	49.1	96.6
		262.4	0.258	0.00099	37.7	92.7
		262.8	0.237	0.00054	41.1	92.0
	0.4	320.4	0.108	0.00177	50.7	98.0
		324.1	0.120	0.00135	50.6	95.3
		321.5	0.108	0.00106	50.5	97.5
	0.6	444.6	0.146	0.00075	47.6	94.6
		446.2	0.229	0.00064	39.7	92.9
		445.1	0.248	0.00028	39.6	91.2
0.1	0.1	110.5	0.423	0.00103	40.3	88.0
		111.1	0.458	0.00098	41.0	89.1
		109.7	0.445	0.00201	42.6	88.7
	0.2	113.8	0.659	0.00142	48.2	63.3
		128.8	0.798	0.00159	48.1	74.6
		114.4	0.802	0.00200	48.5	89.7
	0.4	291.6	1.000	0.00284	44.2	89.9
		295.5	1.000	0.00286	44.5	89.0
		295.6	1.000	0.00283	44.8	89.4
	0.6	394.7	1.000	0.00234	79.3	88.0
		391.6	1.000	0.00232	80.2	87.0
		392.4	1.000	0.00234	81.5	86.0
0.2	0.1	54.8	0.423	0.00326	15.5	90.3
		53.2	0.485	0.00422	15.0	91.0
		53.7	0.467	0.00235	14.8	92.8
	0.2	55.5	0.541	0.00868	13.5	92.7
		54.7	0.538	0.00910	13.3	93.7
		51.5	0.512	0.00976	13.3	98.8
	0.4	139.1	1.000	0.00474	17.6	95.5
		134.3	1.000	0.00478	17.5	99.0
		140.4	1.000	0.00464	17.8	90.0
	0.6	137.9	1.000	0.00514	21.3	90.0
		141.0	1.000	0.00504	21.1	95.5
		137.1	1.000	0.00525	21.6	95.9
0.3	0.1	42.8	0.433	0.00688	13.4	88.4
		43.5	0.425	0.00654	12.9	86.5
		44.4	0.422	0.00695	12.5	89.1
	0.2	52.4	0.522	0.00978	12.5	82.1
		49.0	0.493	0.01038	12.1	77.0
		45.1	0.459	0.01117	12.1	89.6
	0.4	63.7	0.616	0.00853	13.8	94.4
		64.2	0.620	0.00853	14.0	97.2
		64.3	0.625	0.00889	14.3	95.7
	0.6	109.5	0.957	0.00470	12.7	85.0
		121.6	1.000	0.00418	11.7	90.9
		117.4	1.000	0.00428	11.8	89.4

Note: data for Figure 4.5

Table A2.1.2 Dynamic light scattering data of bicontinuous microemulsion.

$TiCl_4$ (M)	% NaCl	Zave	Poly	Fit error	% Merit	% In range
0.0	1.0	37.5	1.000	0.00123	48.1	87.9
		38.3	1.000	0.00210	39.9	87.7
		40.2	1.000	0.00141	48.0	86.7
	1.4	48.8	1.000	0.00286	44.6	81.4
		39.7	1.000	0.00188	44.6	82.9
		42.2	1.000	0.00409	47.0	81.1
	1.8	67.6	1.000	0.00083	43.5	87.7
		64.0	1.000	0.00074	48.1	86.8
		60.8	1.000	0.00083	44.3	88.0
	2.0	81.1	1.000	0.00088	40.5	85.1
		72.0	1.000	0.00087	48.6	87.0
		88.9	1.000	0.00069	42.2	88.8
0.1	1.0	32.4	0.453	0.00123	42.7	71.3
		31.9	0.444	0.00127	41.9	71.5
		32.0	0.478	0.00181	42.5	71.5
	1.4	35.5	0.462	0.00121	35.2	80.9
		38.5	0.325	0.00162	51.5	90.3
		37.7	0.488	0.00124	47.7	90.0
	1.8	50.2	0.656	0.00041	44.3	87.6
		51.4	0.719	0.00083	43.2	86.8
		55.0	0.702	0.00067	43.5	88.7
	2.0	79.7	0.638	0.00020	42.7	81.3
		78.9	0.638	0.00030	43.6	83.7
		77.7	0.620	0.00025	41.9	71.5
0.2	1.0	32.9	0.425	0.00076	41.0	88.5
		33.5	0.419	0.00041	43.2	87.7
		33.4	0.444	0.00075	43.5	86.7
	1.4	34.7	0.408	0.00057	42.6	83.0
		34.5	0.410	0.00049	43.0	84.2
		34.9	0.441	0.00084	38.6	81.9
	1.8	37.9	0.423	0.00079	38.0	82.3
		38.2	0.424	0.00082	37.8	85.2
		38.0	0.440	0.00083	37.9	86.2
	2.0	42.2	0.404	0.00093	33.7	87.5
		43.3	0.436	0.00090	30.4	81.6
		43.0	0.422	0.00090	33.0	86.5
0.3	1.0	38.3	0.156	0.00274	64.3	97.7
		34.0	0.119	0.00041	63.2	98.5
		33.5	0.159	0.00183	63.5	97.7
	1.4	39.7	0.151	0.00168	61.0	97.6
		38.8	0.190	0.00217	58.1	96.8
		38.8	0.178	0.00181	59.9	98.7
	1.8	43.0	0.153	0.00125	57.9	96.7
		43.7	0.174	0.00189	48.7	97.8
		43.6	0.189	0.00067	49.1	92.7
	2.0	45.9	0.144	0.00176	63.4	97.7
		46.2	0.178	0.00076	62.8	95.2
		46.7	0.200	0.00127	62.3	91.5

Note: data for Figure 4.6 (a)

Table A2.1.3 Dynamic light scattering data of w/o microemulsion.

$TiCl_4$ (M)	% NaCl	Zave	Poly	Fit error	% Merit	% In range
0.0	2.5	82.4	0.728	0.00424	51.3	95.0
		81.7	0.761	0.00386	51.6	94.4
		83.0	0.725	0.00399	51.8	94.6
	2.8	64.2	0.628	0.00602	51.2	93.7
		64.4	0.613	0.00595	52.2	94.3
		65.0	0.571	0.00653	56.2	93.9
	3.4	53.2	0.459	0.00504	55.5	96.5
		54.1	0.524	0.00446	54.8	91.9
		54.2	0.480	0.00435	57.5	98.9
	4.0	42.5	0.448	0.00789	51.2	93.9
		43.3	0.455	0.00806	51.3	93.9
		44.4	0.458	0.00723	49.6	99.8
0.1	2.5	64.7	0.741	0.00080	8.7	75.7
		65.0	0.728	0.00058	8.6	80.6
		64.3	0.721	0.00045	8.1	80.9
	2.8	52.5	0.773	0.00046	9.0	84.6
		51.2	0.724	0.00062	9.0	92.1
		53.4	0.796	0.00047	9.6	86.6
	3.4	47.1	0.958	0.00110	17.7	79.9
		42.4	0.863	0.00149	16.8	78.5
		43.8	0.909	0.00149	16.6	76.6
	4.0	31.2	0.707	0.00290	10.9	72.8
		32.7	0.667	0.00159	11.9	80.2
		33.4	0.664	0.00179	11.6	79.8
0.2	2.5	69.1	0.418	0.00046	36.1	85.2
		70.5	0.429	0.00042	36.4	92.6
		74.0	0.408	0.00047	36.3	95.1
	2.8	45.2	0.386	0.00068	37.1	82.8
		46.6	0.355	0.00073	38.1	89.7
		47.0	0.368	0.00069	37.6	93.0
	3.4	25.4	0.423	0.00102	34.0	79.1
		24.3	0.310	0.00034	35.0	81.7
		22.8	0.285	0.00145	35.4	91.2
	4.0	19.9	0.361	0.00150	30.2	88.5
		22.3	0.445	0.00255	30.7	86.6
		21.4	0.415	0.00200	30.2	81.4
0.3	2.5	51.6	0.392	0.00047	35.8	89.0
		52.1	0.438	0.00105	35.4	82.9
		49.8	0.413	0.00082	36.5	87.6
	2.8	43.7	0.435	0.00062	31.7	83.7
		42.0	0.415	0.00048	32.2	84.0
		43.3	0.439	0.00056	32.4	81.5
	3.4	24.0	0.567	0.00027	11.0	81.9
		24.3	0.563	0.00030	10.9	80.3
		23.8	0.586	0.00040	11.3	84.8
	4.0	19.9	0.264	0.00049	37.2	93.3
		20.0	0.283	0.00088	37.5	96.4
		19.8	0.284	0.00069	37.2	95.7

Note: data for Figure 4.7 (a)

Table A2.2 Coulometer data for determination amount of water.

$TiCl_4$ (M)	% NaCl	% H_2O		
		1	2	3
0.0	1.0	59.89	59.77	59.46
	1.4	57.02	56.29	55.99
	1.8	49.21	49.06	48.94
	2.0	30.02	29.96	29.45
	2.5	4.650	4.614	4.866
	2.8	4.473	4.281	4.292
	3.4	3.952	3.950	3.901
	4.0	3.747	3.823	3.711
0.1	1.0	59.03	58.97	59.11
	1.4	56.19	55.85	55.93
	1.8	48.79	47.98	47.69
	2.0	29.95	29.77	29.80
	2.5	4.867	4.758	4.848
	2.8	4.596	4.688	4.491
	3.4	4.264	4.139	4.242
	4.0	3.986	3.975	3.825
0.2	1.0	60.01	59.79	59.55
	1.4	54.93	55.71	55.49
	1.8	50.03	49.87	49.35
	2.0	29.68	32.13	31.54
	2.5	4.553	4.611	4.657
	2.8	4.507	4.338	4.300
	3.4	4.048	3.983	3.962
	4.0	3.788	3.596	3.708
0.3	1.0	59.77	60.02	59.63
	1.4	57.03	56.97	56.55
	1.8	50.93	51.02	50.77
	2.0	30.03	29.78	29.80
	2.5	4.324	4.460	4.628
	2.8	3.985	4.087	4.333
	3.4	3.823	4.040	3.961
	4.0	3.741	3.705	3.563

Note: data for Figure 4.6 (b) and 4.7 (b)

Table A2.3 Summary of effect of $TiCl_4$ concentration.

$TiCl_4$ (M)	O/W Microemulsion			Bicontinuous Microemulsion			W/O Microemulsion		
	%NaCl	Size (nm)	H_2O (%)	%NaCl	Size (nm)	H_2O (%)	%NaCl	Size (nm)	H_2O (%)
0.0	0.1	149.17±1.19	N/A	1.0	38.67±1.39	59.71±0.22	2.5	82.37±0.65	4.71±0.14
	0.2	261.83±1.34	N/A	1.4	43.57±4.70	56.43±0.53	2.8	64.53±0.42	4.35±0.11
	0.4	322.0±1.90	N/A	1.8	64.13±3.40	49.07±0.14	3.4	53.83±0.55	3.93±0.03
	0.6	445.30±0.82	N/A	2.0	80.67±8.46	29.81±0.31	4.0	43.40±0.95	3.76±0.06
0.1	0.1	110.43±0.70	N/A	1.0	32.10±0.26	59.04±0.07	2.5	64.67±0.35	4.82±0.06
	0.2	119.00±8.49	N/A	1.4	37.23±1.55	55.99±0.18	2.8	52.37±1.11	4.59±0.10
	0.4	294.23±2.28	N/A	1.8	52.20±2.50	48.15±0.57	3.4	44.43±2.41	4.22±0.07
	0.6	392.90±1.61	N/A	2.0	78.77±1.01	29.84±0.10	4.0	32.43±1.12	3.93±0.09
0.2	0.1	53.90±0.82	N/A	1.0	33.27±0.32	59.78±0.23	2.5	71.20±2.52	4.61±0.05
	0.2	53.90±2.121	N/A	1.4	34.70±0.20	55.38±0.40	2.8	46.27±0.95	4.38±0.11
	0.4	137.93±3.21	N/A	1.8	38.03±0.15	49.75±0.36	3.4	24.17±1.31	4.00±0.04
	0.6	138.67±2.06	N/A	2.0	42.83±0.57	31.12±1.28	4.0	21.20±1.21	3.70±0.10
0.3	0.1	43.57±0.80	N/A	1.0	35.27±2.64	59.81±0.20	2.5	51.17±1.21	4.47±0.15
	0.2	48.83±3.65	N/A	1.4	39.10±0.52	56.85±0.26	2.8	43.00±0.89	4.14±0.18
	0.4	64.07±0.32	N/A	1.8	43.43±0.38	50.91±0.13	3.4	24.03±0.25	3.94±0.11
	0.6	116.17±6.14	N/A	2.0	46.27±0.40	29.87±0.14	4.0	19.90±0.10	3.67±0.09

* Excess water phase

A3 Effects of Weight Ratio of Oil to Aqueous Phases

Weight Ratio	6.0% AOT in n-heptane (mL)	0.3 M $TiCl_4$ (mL)	NaCl		Type of Microemulsion
			g	wt%	
0.8	11.7055	10	0.01	0.1	Type I (o/w)
	11.7172	10	0.02	0.2	
	11.7408	10	0.04	0.4	
	11.7644	10	0.06	0.6	
	11.8119	10	0.10	1.0	Type III (bicontinuous)
	11.8598	10	0.14	1.4	
	11.9081	10	0.18	1.8	
	11.9325	10	0.20	2.0	
	11.9936	10	0.25	2.5	Type II (w/o)
	12.0307	10	0.28	2.8	
	12.1054	10	0.34	3.4	
	12.1810	10	0.40	4.0	
Weight Ratio	6.0% AOT in n-heptane (mL)	0.3 M $TiCl_4$ (mL)	NaCl		Type of Microemulsion
			g	wt%	
1.0	14.6345	10	0.01	0.1	Type I (o/w)
	14.6491	10	0.02	0.2	
	14.6784	10	0.04	0.4	
	14.7076	10	0.06	0.6	
	14.7661	10	0.10	1.0	Type III (bicontinuous)
	14.8246	10	0.14	1.4	
	14.8830	10	0.18	1.8	
	14.9123	10	0.20	2.0	
	14.9854	10	0.25	2.5	Type II (w/o)
	15.0292	10	0.28	2.8	
	15.1170	10	0.34	3.4	
	15.2047	10	0.40	4.0	
Weight Ratio	6.0% AOT in n-heptane (mL)	0.3 M $TiCl_4$ (mL)	NaCl		Type of Microemulsion
			g	wt%	
1.2	17.5646	10	0.01	0.1	Type I (o/w)
	17.5822	10	0.02	0.2	
	17.6175	10	0.04	0.4	
	17.6530	10	0.06	0.6	
	17.7243	10	0.10	1.0	Type III (bicontinuous)
	17.7962	10	0.14	1.4	
	17.8687	10	0.18	1.8	
	17.9052	10	0.20	2.0	
	17.9970	10	0.25	2.5	Type II (w/o)
	18.0525	10	0.28	2.8	
	18.1647	10	0.34	3.4	
	18.2782	10	0.40	4.0	

A3.1 Dynamic Light Scattering Data

Table A3.1.1 Dynamic light scattering data of o/w microemulsion.

Weight Ratio	% NaCl	Zave	Poly	Fit error	% Merit	% In range
0.8	0.1	17.2	0.133	0.00140	50.4	97.9
		17.1	0.120	0.00178	50.3	96.7
		17.2	0.123	0.00119	50.0	97.2
	0.2	19.6	0.146	0.00115	50.0	96.4
		19.7	0.160	0.00156	49.7	94.4
		19.9	0.108	0.00222	49.7	99.4
	0.4	20.3	0.120	0.00161	51.4	98.4
		20.0	0.123	0.00176	51.8	97.0
		19.8	0.120	0.00168	51.7	98.3
	0.6	25.4	0.195	0.00088	52.3	89.7
		24.8	0.191	0.00038	52.7	98.0
		25.0	0.191	0.00099	53.1	94.6
1.0	0.1	12.4	0.204	0.00040	48.1	93.2
		12.3	0.209	0.00128	48.1	92.5
		11.9	0.176	0.00083	49.2	91.9
	0.2	12.4	0.186	0.00090	49.7	94.7
		12.4	0.142	0.00335	47.9	96.8
		12.0	0.097	0.00459	46.6	98.1
	0.4	17.8	0.400	0.00355	32.3	85.0
		17.7	0.410	0.00434	30.5	83.6
		16.5	0.376	0.00420	31.9	88.0
	0.6	18.0	0.388	0.00368	43.6	83.8
		18.2	0.389	0.00342	37.0	86.4
		17.7	0.327	0.00261	39.8	90.0
1.2	0.1	15.0	0.140	0.00206	51.5	92.0
		14.8	0.113	0.00211	51.9	97.5
		14.5	0.125	0.00140	51.8	98.0
	0.2	15.1	0.133	0.00222	49.1	96.6
		15.0	0.258	0.00099	37.7	92.7
		15.5	0.237	0.00054	41.1	92.0
	0.4	16.0	0.108	0.00177	50.7	98.0
		15.9	0.120	0.00135	50.6	95.3
		15.6	0.108	0.00106	50.5	97.5
	0.6	17.9	0.146	0.00075	47.6	94.6
		18.4	0.229	0.00064	39.7	92.9
		18.6	0.248	0.00028	39.6	91.2

Note: data for Figure 4.8

Table A3.1.2 Dynamic light scattering data of bicontinuous microemulsion.

Weight Ratio	% NaCl	Zave	Poly	Fit error	% Merit	% In range
0.8	1.0	33.7	0.456	0.00100	36.7	83.7
		33.5	0.444	0.00099	33.0	87.8
		34.0	0.474	0.00121	34.2	82.9
	1.4	34.9	0.423	0.00078	30.1	81.2
		34.1	0.459	0.00128	28.6	78.9
		36.4	0.419	0.00039	28.0	78.4
	1.8	36.0	0.478	0.00101	30.4	79.8
		35.7	0.467	0.00088	33.4	82.3
		35.3	0.467	0.00089	32.7	85.0
	2.0	37.4	0.421	0.00100	31.1	87.0
		36.6	0.386	0.00079	29.7	85.8
		37.9	0.324	0.00101	29.7	89.5
1.0	1.0	38.3	0.156	0.00274	64.3	97.7
		34.0	0.119	0.00041	63.2	98.5
		33.5	0.159	0.00183	63.5	97.7
	1.4	39.7	0.151	0.00168	61.0	97.6
		38.8	0.190	0.00217	58.1	96.8
		38.8	0.178	0.00181	59.9	98.7
	1.8	43.0	0.153	0.00125	57.9	96.7
		43.7	0.174	0.00189	48.7	97.8
		43.6	0.189	0.00067	49.1	92.7
	2.0	45.9	0.144	0.00176	63.4	97.7
		46.2	0.178	0.00076	62.8	95.2
		46.7	0.200	0.00127	62.3	91.5
1.2	1.0	40.0	0.428	0.00178	39.7	84.8
		39.5	0.462	0.00097	40.0	87.8
		39.6	0.467	0.00154	38.7	87.7
	1.4	42.2	0.439	0.00077	30.8	79.6
		42.0	0.438	0.00070	29.7	79.9
		42.5	0.448	0.00081	31.4	79.6
	1.8	44.5	0.443	0.00098	39.7	80.2
		45.9	0.488	0.00089	37.7	79.7
		44.3	0.435	0.00092	37.8	79.5
	2.0	47.8	0.444	0.00098	27.5	79.4
		47.0	0.446	0.00095	27.7	79.7
		48.1	0.446	0.00116	27.0	78.2

Note: data for Figure 4.9 (a)

Table A3.1.3 Dynamic light scattering data of w/o microemulsion.

Weight Ratio	% NaCl	Zave	Poly	Fit error	% Merit	% In range
0.8	2.5	27.5	0.589	0.00283	55.3	69.0
		25.1	0.509	0.00246	58.7	82.6
		23.9	0.481	0.00259	57.9	84.2
	2.8	25.6	0.564	0.00304	53.4	68.0
		21.8	0.467	0.00303	55.9	79.1
		23.2	0.474	0.00260	54.0	74.2
	3.4	23.0	0.568	0.00497	53.2	66.4
		22.6	0.561	0.00528	56.1	71.1
		21.9	0.539	0.00501	54.1	69.5
	4.0	22.5	0.590	0.00644	53.4	68.9
		21.1	0.556	0.00689	53.8	72.8
		21.4	0.566	0.00695	53.4	71.3
1.0	2.5	30.2	0.728	0.00424	51.3	65.0
		31.9	0.761	0.00386	51.6	64.4
		30.3	0.725	0.00399	51.8	64.6
	2.8	24.3	0.628	0.00602	51.2	63.7
		23.7	0.613	0.00595	52.2	64.3
		22.0	0.571	0.00653	56.2	73.9
	3.4	18.9	0.459	0.00504	55.5	76.5
		22.2	0.524	0.00446	54.8	71.9
		20.8	0.480	0.00435	57.5	78.9
	4.0	16.5	0.448	0.00789	51.2	73.9
		16.7	0.455	0.00806	51.3	73.9
		17.1	0.458	0.00723	49.6	69.8
1.2	2.5	32.3	0.752	0.00316	44.6	47.5
		31.8	0.735	0.00316	47.6	55.2
		29.7	0.692	0.00363	53.2	70.5
	2.8	23.7	0.601	0.00561	52.7	73.1
		27.4	0.688	0.00492	51.5	63.5
		23.3	0.589	0.00551	53.6	72.1
	3.4	23.8	0.575	0.00439	49.3	73.1
		24.5	0.589	0.00431	48.7	72.5
		23.1	0.557	0.00459	50.7	79.5
	4.0	21.8	0.565	0.00625	52.9	69.9
		24.4	0.629	0.00592	53.9	70.8
		22.5	0.580	0.00588	51.9	67.4

Note: data for Figure 4.10 (a)

Table A3.2 Coulometer data for determination amount of water.

Weight Ratio	% NaCl	% H_2O		
		1	2	3
0.8	1.0	63.02	62.78	62.89
	1.4	58.36	57.73	59.98
	1.8	52.20	51.93	52.11
	2.0	30.41	31.32	31.06
	2.5	5.132	5.154	4.929
	2.8	4.421	4.566	4.547
	3.4	4.260	4.266	4.347
	4.0	3.956	3.900	4.036
1.0	1.0	59.77	60.02	59.63
	1.4	57.03	56.97	56.55
	1.8	50.93	51.02	50.77
	2.0	30.03	29.78	29.80
	2.5	4.650	4.770	4.945
	2.8	4.473	4.592	4.580
	3.4	3.952	4.279	4.253
	4.0	3.747	4.062	4.059
1.2	1.0	60.02	59.87	59.96
	1.4	57.76	58.68	58.79
	1.8	51.03	50.77	50.68
	2.0	31.04	30.89	30.76
	2.5	4.781	4.614	4.866
	2.8	4.716	4.281	4.292
	3.4	4.296	3.950	3.901
	4.0	4.080	3.823	3.711

Note: data for Figure 4.9 (b) and 4.10 (b)

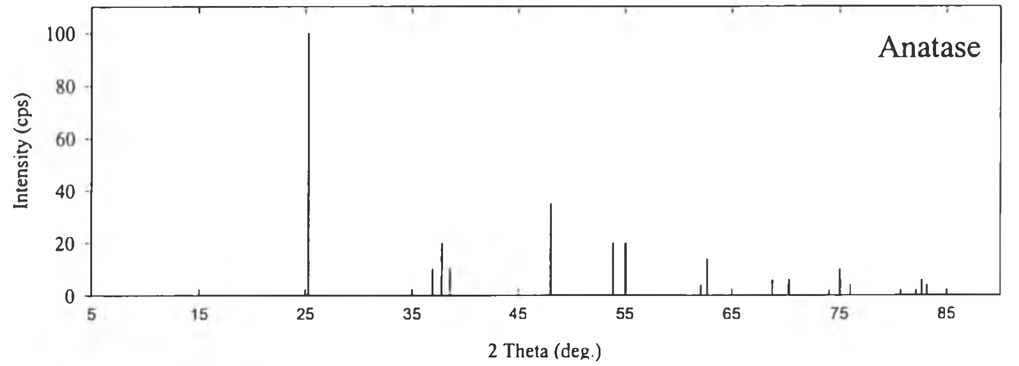
Table A3.3 Summary of effect of weight ratio.

Weight Ratio	O/W Microemulsion			Bicontinuous Microemulsion			W/O Microemulsion		
	%NaCl	Size (nm)	H_2O (%)	%NaCl	Size (nm)	H_2O (%)	%NaCl	Size (nm)	H_2O (%)
0.8	0.1	17.17±0.06	N/A	1.0	33.73±0.25	62.90±0.12	2.5	25.50±1.83	5.07±0.12
	0.2	19.73±0.15	N/A	1.4	35.13±1.17	58.69±1.16	2.8	23.53±1.92	4.51±0.08
	0.4	20.03±0.25	N/A	1.8	35.67±0.35	52.08±0.14	3.4	22.50±0.56	4.29±0.05
	0.6	25.07±0.31	N/A	2.0	37.30±0.66	30.93±0.47	4.0	21.67±0.74	3.96±0.07
1.0	0.1	12.20±0.26	N/A	1.0	35.27±2.64	59.81±0.20	2.5	30.80±0.95	4.79±0.15
	0.2	12.27±0.23	N/A	1.4	39.10±0.52	56.85±0.26	2.8	23.33±1.19	4.55±0.07
	0.4	17.33±0.72	N/A	1.8	43.43±0.38	50.91±0.13	3.4	20.63±1.66	4.16±0.18
	0.6	17.97±0.25	N/A	2.0	46.27±0.40	29.87±0.14	4.0	16.77±0.31	3.96±0.18
1.2	0.1	14.77±0.25	N/A	1.0	31.27±1.38	59.95±0.08	2.5	31.27±1.38	4.75±0.13
	0.2	15.20±0.26	N/A	1.4	24.80±2.26	58.41±0.57	2.8	24.80±2.26	4.43±0.15
	0.4	15.83±0.21	N/A	1.8	23.80±0.70	50.83±0.18	3.4	23.80±0.70	4.05±0.22
	0.6	18.30±0.36	N/A	2.0	22.90±1.35	30.90±0.14	4.0	22.90±1.35	3.87±0.19

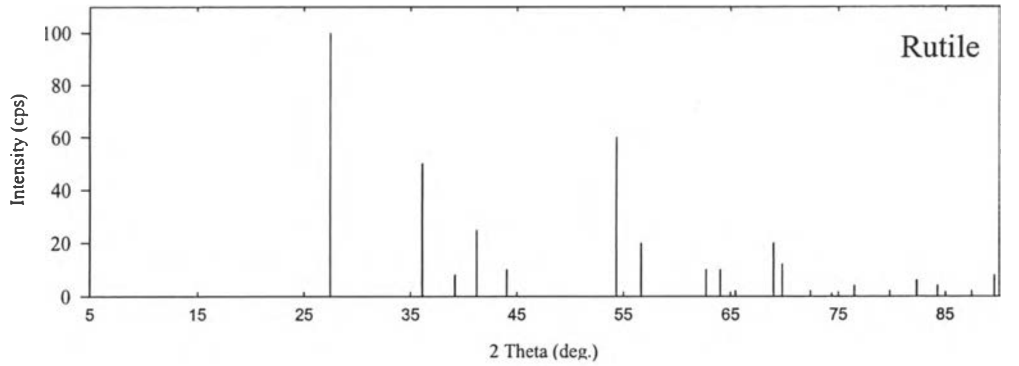
* Excess water phase

APPENDIX B
Characterization of Titanium Dioxide

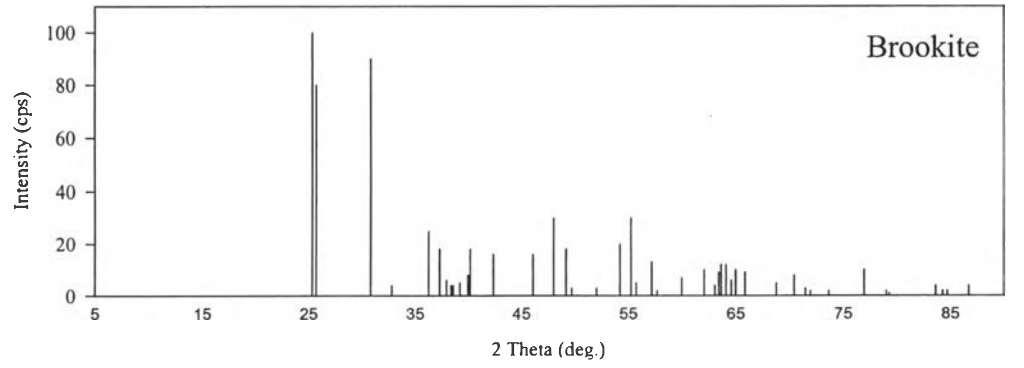
B1 XRD Patterns of TiO_2 Reference



(a)



(b)



(c)

Figure B1 XRD patterns of the important phase of titanium dioxide (a) anatase phase, (b) rutile phase, and (c) brookite phase.

B2 Estimation of TiO_2 Particle Size by XRD

X-ray diffraction patterns were used for the average particle diameter (T) estimation by line broadening measurements in the Debye-Scherrer equation (Jung and Park, 1999):

$$T = K\lambda / \beta\cos\theta \qquad \text{------------------ (10)}$$

where

λ	=	the wave length (0.154 nm)
K	=	the Debye-Scherrer constant (assume equal to 0.9)
β	=	the full width at half maximum (FWHM) of the broadened peak (radius)
θ	=	the Bragg angle of the reflection (degree)
T	=	the crystal size (nm)

Table B2 Size estimation.

Samples	2θ	FWHM	θ	β (radius)	T (nm)
P25	25.28	0.23529	12.64	4.1070×10^{-3}	38.43
0.4% NaCl	25.18	0.28235	12.59	4.9279×10^{-3}	32.02
2.0% NaCl	25.20	0.23529	12.60	4.1066×10^{-3}	38.43
4.0% NaCl	25.28	0.28235	12.64	4.9279×10^{-3}	32.03
5.0% NaCl	25.24	0.30588	12.62	5.3386×10^{-3}	29.56
6.0% NaCl	25.30	0.35882	12.65	6.2626×10^{-3}	25.20
7.0% NaCl	25.26	0.47059	12.63	8.2133×10^{-3}	19.22
8.0% NaCl	25.34	0.61176	12.67	10.6770×10^{-3}	14.78

B3 Calculation of Rutile Percentage

Amount of rutile phase can calculated form the equation (Jung and Park, 1999):

$$\%\text{rutile} = \frac{1}{(\frac{A}{R}0.884 + 1)} \quad 100 \qquad \text{------------------ (11)}$$

where

A = peak area for major anatase phase at 2θ = 25.3

R = peak area for major rutile phase at 2θ = 27.5

Table B3 Amount of rutile.

Samples	A	R	% rutile
P25	1750.280	492.660	24.151
4.0% NaCl	1369.656	281.826	18.882
5.0% NaCl	1934.532	213.192	11.085
6.0% NaCl	2523.276	154.530	6.479

APPENDIX C

Photocatalytic Study of Titanium Dioxide Particles

C1 Chemicals

HPLC grade of acetonitrile (CH_3CN) and methanol as a mobile phase for HPLC analysis were obtained from Lab-Scan (Bangkok, Thailand). Analytical reagent (AR) grade ethanol (99.8%) as a solvent and 98% purity of 4-chlorophenol (C_6H_5OCl) or 4-CP as a model pollutant were purchased from BDH Laboratory Supplies (England).

C2 Experimental

100 mL of a solution containing 0.5 mM 4-chlorophenol and 0.5 g/L of TiO_2 was added into a 500 mL batch reactor. A magnetic stirrer continuously mixed the solution during experiment. A UV light source was 11 watt low pressure mercury lamp covering wavelength range of 100-280 nm, immersed into the solution in the batch reactor to activate photocatalytic reaction. The batch reactor was placed into a thermostat bath to control temperature at 25°C and an opaque PVC box for UV protection as shown in Figure C1 covered the whole system.

The solution was continuously stirred for 30 minutes and then the UV lamp was turned on for photocatalytic reaction. Every thirty minutes, the solution was sampled to determine 4-chlorophenol remaining in the solution. The clear sample solution was obtained by a centrifuge and further filtered with a nylon membrane filter (0.2 μm pore size) to remove solid particle remaining.

Concentration of 4-chlorophenol was determined by high performance liquid chromatography, HPLC equipped with UV detector (Hewlett Packard Series 1050) adjusted to 270 nm for detection of 4-chlorophenol and the ODS-2 spherisorb column (125 nm length, 4 mm internal diameter, and 5 μm particle diameter). The mobile phase was a mixture of 40:60 volume ratio of acetronitrile to deionized water with the flow rate of 1.0 ml/min.

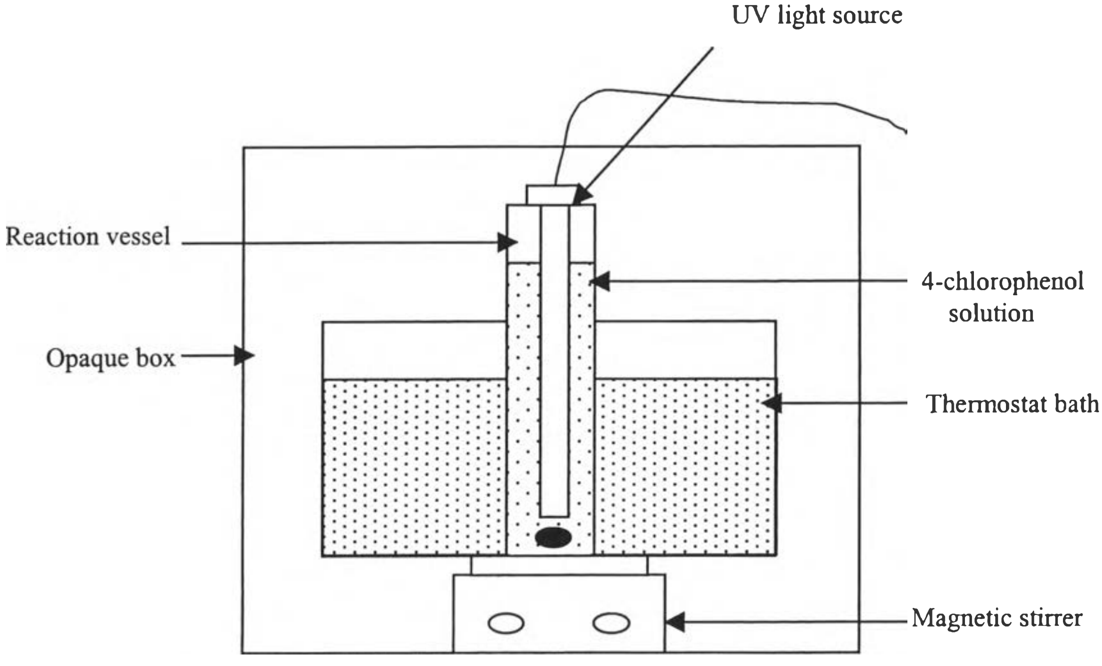


Figure C1 Schematic of the photocatalytic study.

C3 Photocatalytic Study of Titanium Dioxide Particles

The photocatalytic reaction was separated using initial 4-chlorophenol concentration of 0.5 mM and 0.5 g/L TiO_2 catalyst at controlled temperature 25°C. The ralative concentration of 4-chlorophenol at any given time to its initial concentration at time zero (C/C_0) was determined.

Figure C2 shows degradation of 4-chlorophenol with different titanium dioxides. The results show the degradation rate increase as the particle size of TiO_2 decrease. It is noted that TiO_2 obtained from o/w microemulsion yielded similar degradation rate to P25.

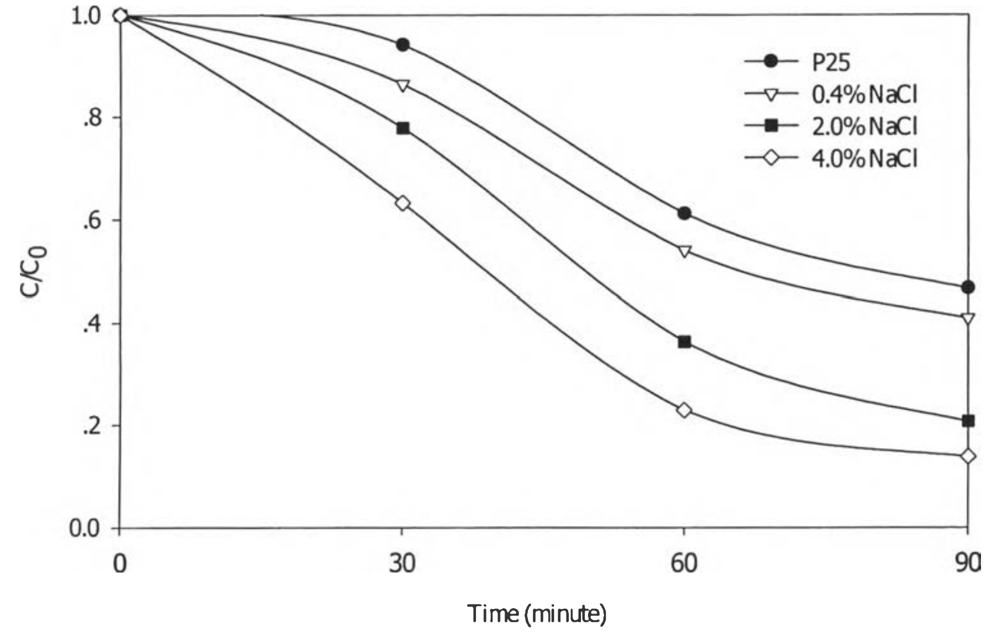


Figure C2 Photocatalytic degradation rate of 4-chlorophenol with different titanium dioxides.

Table C1 HPLC data for 4-chlorophenol analysis.

Initial concentration of 4-chlorophenol = 0.5 mM

Time (min)	P25			0.4% NaCl			2.0% NaCl			4.0% NaCl		
	Area	Conc. (mM)	C/C_0	Area	Conc. (mM)	C/C_0	Area	Conc. (mM)	C/C_0	Area	Conc. (mM)	C/C_0
0	468.658	0.4687	1.0000	439.591	0.4396	1.0000	409.213	0.4092	1.0000	407.037	0.4070	1.0000
30	440.790	0.4408	0.9405	379.532	0.3795	0.8634	318.407	0.3184	0.7781	257.283	0.2573	0.6321
60	286.629	0.2866	0.6116	237.635	0.2376	0.5406	148.827	0.1488	0.3637	93.253	0.0933	0.2291
90	218.784	0.2188	0.4668	179.865	0.1799	0.4092	84.683	0.0847	0.2069	56.017	0.0560	0.1376

Note: data for Figure C2

Table C2 TOC data for 4-chlorophenol analysis.

Time (min)	P25		0.4% NaCl		2.0% NaCl		4.0% NaCl	
	Conc. (ppm)	TOC/TOC_0	Conc. (ppm)	TOC/TOC_0	Conc. (ppm)	TOC/TOC_0	Conc. (ppm)	TOC/TOC_0
0	30.650	1.0000	35.290	1.0000	38.240	1.0000	33.300	1.0000
30	24.940	0.8137	32.820	0.9300	34.630	0.9056	32.100	0.9640
60	19.040	0.6212	32.580	0.9232	33.830	0.8847	31.460	0.9447
90	18.150	0.5922	31.910	0.9042	32.450	0.8486	30.100	0.9039

The factors of relative concentration used throughout this section are C/C_0 and TOC/TOC_0. C/C_0 is ratio of 4-chlorophenol concentrations at any time to its initial concentration at time zero and TOC/TOC_0 is the ratio of TOC concentration in the solution at any time to its initial concentration in the solution at time zero.

The results are comparison in the different catalysts use. The catalysts used were commercial titanium dioxide P25, titanium dioxide synthesized from o/w microemulsion (0.4% NaCl), bicontinuous microemulsion (2.0% NaCl), and w/o microemulsion (4.0% NaCl). The reaction temperature was controlled at constant 25 °C for all experiments. The stating solution is the 0.5 mM 4-chlorophenol and 0.5 g/L catalysts.

Figure C3 show the comparison of different catalysts use for degradation of 4-chlorophenol and TOC in the solution with time respectively. Adding the TiO_2 synthesized from all three types of microemulsion show the TOC degradation rate with titanium dioxide P25 is much higher than TiO_2 synthesized from microemulsion as shown in this figure. That may be attributed to the differences in physical properties of the catalysts as described in Tables 4.2. A higher surface area of the TiO_2 synthesized from microemulsion results in the larger amount of 4-chlorophenol adsorbed on the catalyst surface.

For each types of catalysts use for degradation of 4-chlorophenol, the results are reported in comparison between C/C_0 and TOC/TOC_0 as shown in Figure C2. The results show that TiO_2 synthesized from w/o microemulsion has the highest ability for degradation of 4-chlorophenol than TiO_2 synthesized from the other types and titanium dioxide P25.

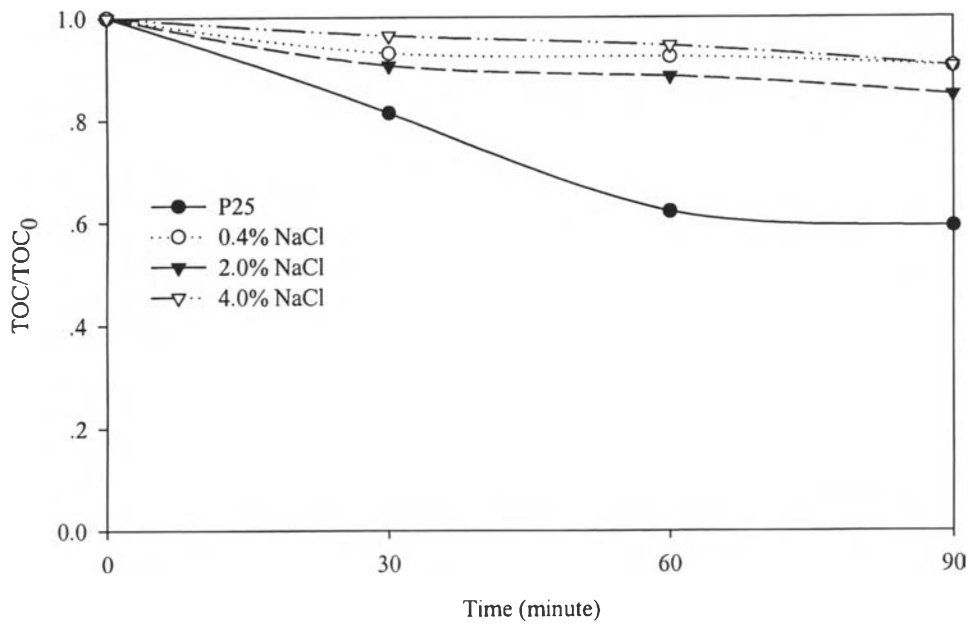
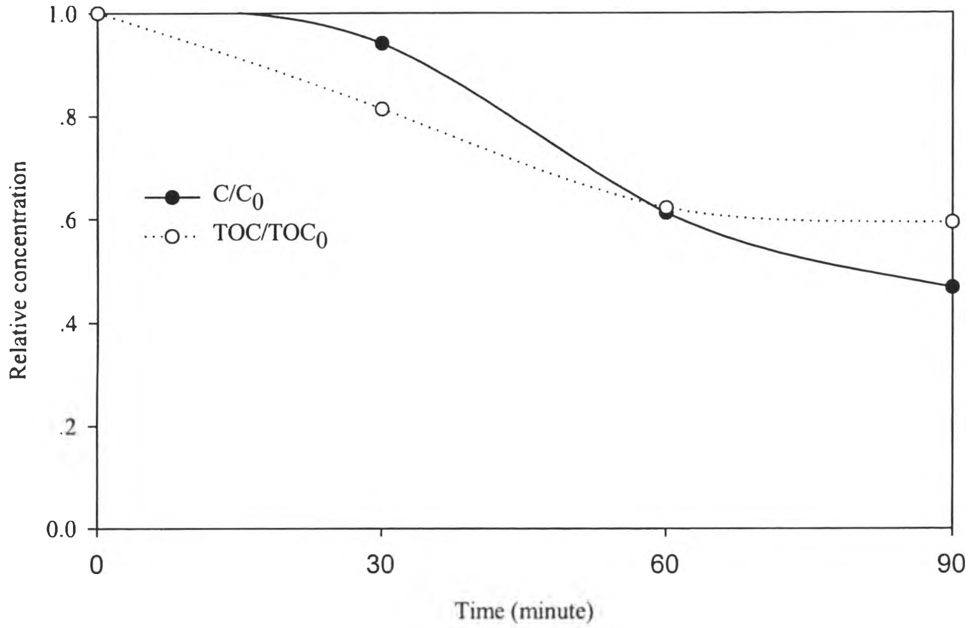
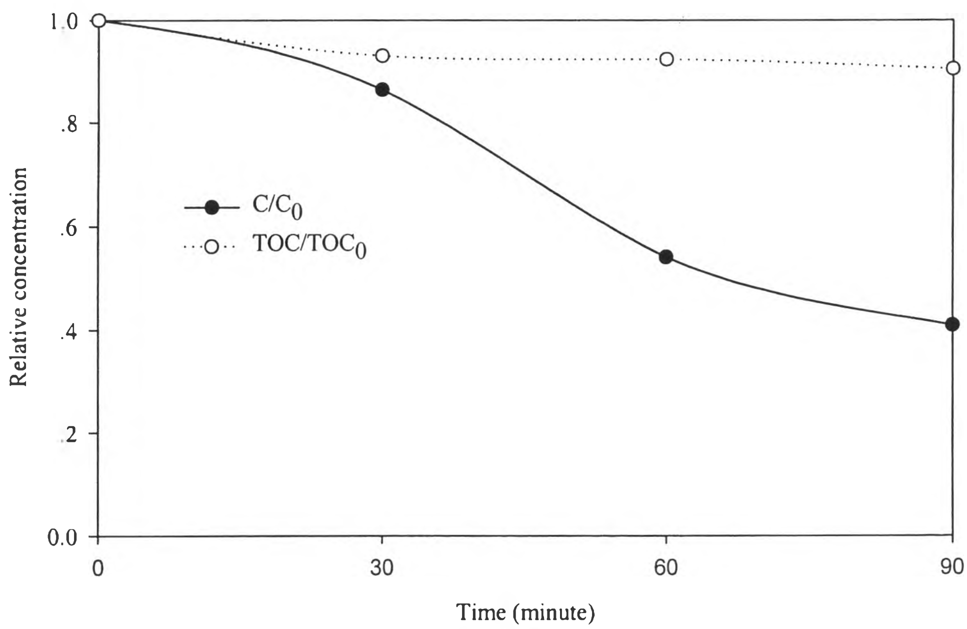


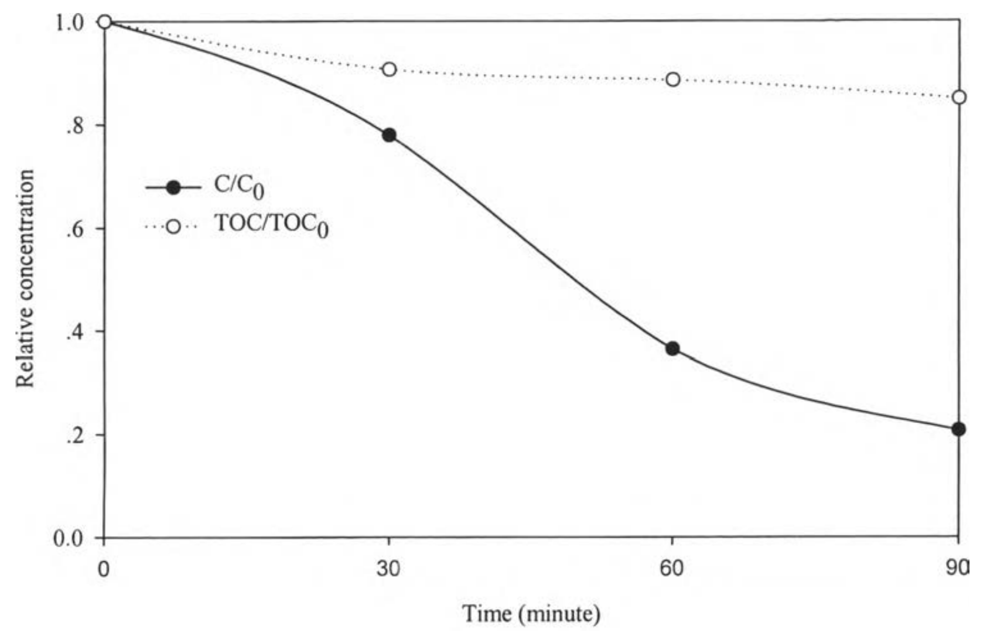
Figure C3 Relative concentration of of TOC with different titanium dioxide.


1.0
.8
.6
.4
.2
0.0
Relative concentration
C/C0
TOC/TOC0
0
30
60
90
Time (minute)

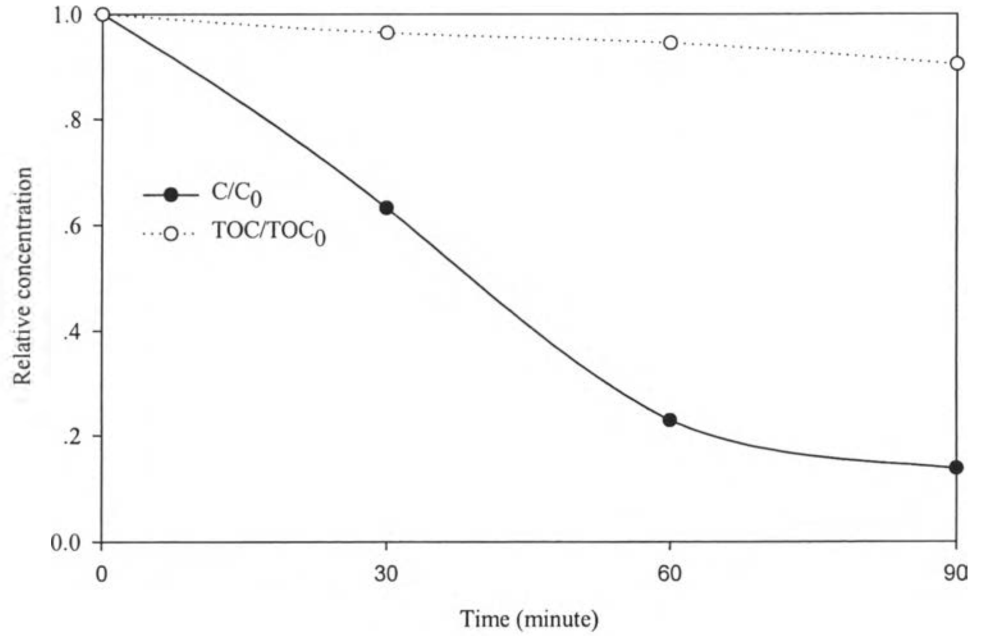
(a)


1.0
.8
.6
.4
.2
0.0
Relative concentration
C/C0
TOC/TOC0
0
30
60
90
Time (minute)

(b)



(c)



(d)

Figure C4 Comparison of relative concentration of C/C_0 and TOC/TOC_0 of (a) commercial titanium dioxide P25 and (b) TiO_2 synthesized from o/w microemulsion, (c) TiO_2 synthesized from bicontinuous microemulsion, and (d) TiO_2 synthesized from w/o microemulsion.

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