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APPENDICES

APPENDIX A

THE METHOD OF GAMUT VOLUME CALCULATION

Statistics Value of Image Data

As reference for objective evaluation of SHIPP Image, evaluation for three kinds of items was done as follows.

1) Statistics value of image data (minimum and maximum values, mean value, variance and covariance, one dimensional histogram)

2) Principal component analysis by analysis of amount of information on color

3) Characteristics of spatial frequency of image (auto-correlation function)

1.1 Statistics Value of Image

Mean value and variance and covariance matrix of each plain pixel can be provided by following formula if all pixels.

[Mean value of pixel]

$$\begin{pmatrix} \overline{P_1} \\ \overline{P_2} \\ \overline{P_3} \end{pmatrix} = \frac{1}{N} \begin{pmatrix} \sum P_1 \\ \sum P_2 \\ \sum P_3 \end{pmatrix} \quad \text{(A-1)}$$

[Variance and covariance matrix]

$$\begin{pmatrix} V_{P_{11}} & V_{P_{12}} & V_{P_{13}} \\ V_{P_{21}} & V_{P_{22}} & V_{P_{23}} \\ V_{P_{31}} & V_{P_{32}} & V_{P_{33}} \end{pmatrix} = \frac{1}{N} \begin{pmatrix} \sum\left(P_1 - \overline{P_1}\right)^2 & \sum\left(P_1 - \overline{P_1}\right)\left(P_2 - \overline{P_2}\right) & \sum\left(P_1 - \overline{P_1}\right)\left(P_3 - \overline{P_3}\right) \\ \sum\left(P_2 - \overline{P_2}\right)\left(P_1 - \overline{P_1}\right) & \sum\left(P_2 - \overline{P_2}\right)^2 & \sum\left(P_2 - \overline{P_2}\right)\left(P_3 - \overline{P_3}\right) \\ \sum\left(P_3 - \overline{P_3}\right)\left(P_1 - \overline{P_1}\right) & \sum\left(P_3 - \overline{P_3}\right)\left(P_2 - \overline{P_2}\right) & \sum\left(P_3 - \overline{P_3}\right)^2 \end{pmatrix}$$

(A-2)

Diagonal elements of variance and covariance matrix such as V_{11}, V_{22} and V_{33} are variance of each plain pixel and off-diagonal elements express covariance of corresponded plain pixels corresponded. Correlation of couple of plain pixels is provided as follows.

$$\begin{pmatrix} R_{P_{11}} & R_{P_{12}} & R_{P_{13}} \\ R_{P_{21}} & R_{P_{22}} & R_{P_{23}} \\ R_{P_{31}} & R_{P_{32}} & R_{P_{33}} \end{pmatrix} = \begin{pmatrix} 1 & \dfrac{V_{P_{12}}}{\sqrt{V_{P_{11}}} \cdot \sqrt{V_{P_{22}}}} & \dfrac{V_{P_{13}}}{\sqrt{V_{P_{11}}} \cdot \sqrt{V_{P_{33}}}} \\ \dfrac{V_{P_{21}}}{\sqrt{V_{P_{22}}} \cdot \sqrt{V_{P_{11}}}} & 1 & \dfrac{V_{P_{23}}}{\sqrt{V_{P_{22}}} \cdot \sqrt{V_{P_{33}}}} \\ \dfrac{V_{P_{31}}}{\sqrt{V_{P_{33}}} \cdot \sqrt{V_{P_{11}}}} & \dfrac{V_{P_{32}}}{\sqrt{V_{P_{33}}} \cdot \sqrt{V_{P_{11}}}} & 1 \end{pmatrix} \quad \text{(A-3)}$$

It is difficult to determine color-distribution by examination of variance of each plain since in RGB image, correlation among each plain is generally high. Therefore, it shall be considered to find objectively color-distribution of image using method of principal component analysis.

What we shall pay attention in taking statistics of image, is that each natural image includes identifying text of "SHIPP RGB", "SHIPP LAB", and "SHIPP XYZ" according to its color space. Since a part of letter (text) has 0 to 255, respectively for "SHIPP RGB" and "SHIPP LAB" and 0 or data corresponding to standard white color

D65 for "SHIPP XYZ", it is inconvenient to calculate statistics value by including area of letter (text) to know characteristics of image. From this reason, it is calculated by area of image excluding area of letter (text) as shown in Figure A-1 and Table A-1.

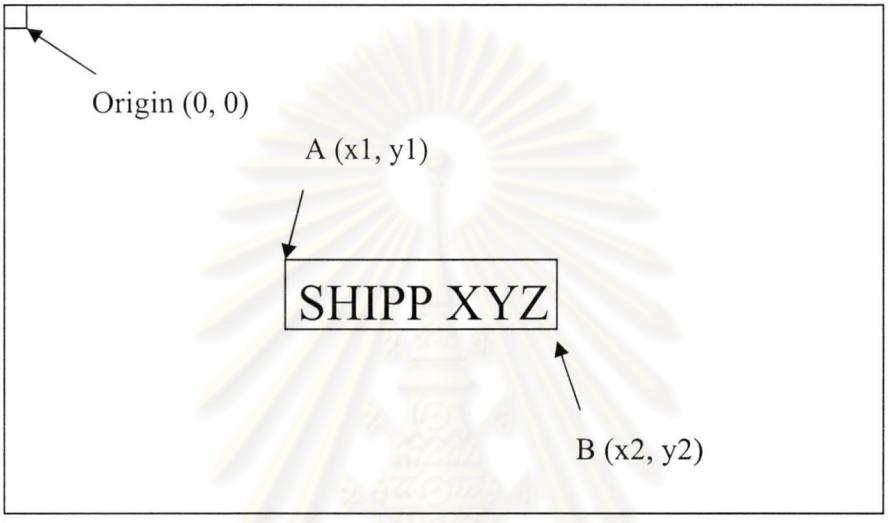


Figure A-1 Coordinate of Area of Letter (Text)

Table A-1 Position and Size of Area of Letter (Text)

Image	A (x1, y1)	B (x2, y2)	Size
BrideRGB	(2770, 35)	(3035, 71)	266 x 37
HarborRGB	(34, 35)	(299, 71)	266 x 37
WoolRGB	(3794, 35)	(4059, 71)	266 x 37
BottlesRGB	(2770, 35)	(3035, 71)	266 x 37
BrideLAB	(2770, 36)	(3021, 72)	252 x 37
HarborLAB	(34, 36)	(285, 72)	252 x 37
WoolLAB	(3794, 36)	(4045, 72)	252 x 37
BottlesLAB	(2770, 36)	(3021, 72)	252 x 37
BrideXYZ	(2770, 36)	(3016, 72)	247 x 37
HarborXYZ	(34, 36)	(280, 72)	247 x 37
WoolXYZ	(3794, 36)	(4040, 72)	247 x 37
BottlesXYZ	(2770, 36)	(3010, 72)	247 x 37

1.2 Principal Component Analysis

Principal component analysis is a method to express effectively information of original space with fewer variables done by orthogonal transformation aiming to obtain a minimum correlation of each variable against multivariate space. To find this principal component, it is known to solve eigen value problem.

Provided V for 3 rows and 3 columns of variance and covariance matrix, x for 3 columns of vector, and λ for scalar, general solution for following equation shall be found.

$$V \cdot x = \lambda \cdot x \qquad \text{(A-4)}$$

Three values of λ to meet the equation above are regarded as eigen value (characteristic value) and x as eigen vector (characteristic vector). Principal component is eigen vector (characteristic vector) of variance and covariance matrix and variance of principal component is equaling to eigen value (characteristic value). Also, contribution ratio is provided by following equation:

Contribution ratio of The nth principal component = eigen value of the nth principal component / sum of eigen values (A-5)

The value found by the equation above shows how many degree the principal component reflects original information.

Since three principal components found by this method are orthogonal to each other, the value found by multiplication of standard deviation of each principal component shows•• spread of three-dimensional color distribution; in short, it shows cubic volume. Therefore, three-dimensional cubic volume of V3D is defined as follows.

$$V_{3D} = \sqrt{\lambda_1} \cdot \sqrt{\lambda_2} \cdot \sqrt{\lambda_3} \qquad \text{(A-6)}$$

It is shown from Tables 4.2 to 4.13 for the results of statistics value and principal component analysis of each image, and from Figures 4.2 to 4.13 for one-dimensional histogram.

APPENDIX B

THE Q/M VALUES OF VARIOUS DEVELOPERS EVALUATED BY A BLOW-OFF METHOD

Table B-1 The q/m values of developer, four types of toner and TSV-200, at 800 rpm by MS1 Minishaker

Concentration (wt%)	Time (sec.)	q/m (μC/g)			
		Black toner	Cyan toner	Magenta toner	Yellow toner
1 wt%	3	-	53.85	49.73	54.19
	5	-	55.50	53.87	56.02
	10	-	57.16	55.86	57.82
	15	37.23	57.46	57.60	56.77
	30	43.31	55.00	57.38	57.19
	60	40.62	55.66	59.12	57.45
	90	43.23	57.48	59.10	57.49
	120	40.85	58.17	58.63	60.05
	240	40.46	58.17	59.69	60.57
	360	41.91	59.06	59.02	61.01
3 wt%	3	-	35.63	35.04	33.03
	5	-	42.35	38.48	40.23
	10	-	49.18	48.42	47.55
	15	25.38	48.93	49.31	48.09
	30	35.38	52.96	49.32	48.32
	60	40.23	53.30	51.79	49.62
	90	41.28	53.45	51.86	51.76
	120	39.94	53.35	51.70	53.15
	240	40.15	53.32	51.36	54.06
	360	40.60	53.99	53.23	55.30
5 wt%	3	-	20.68	20.58	20.84
	5	-	30.69	32.23	30.87
	10	-	40.71	39.27	40.29
	15	14.97	41.27	42.50	40.35
	30	24.67	41.41	45.99	43.20
	60	29.77	41.42	46.74	43.77
	90	32.51	42.02	46.36	45.81
	120	33.20	45.26	47.32	48.39
	240	33.80	47.08	46.86	48.65
	360	35.83	47.57	46.11	50.37

Table B-1 (continued)

Concentration (wt%)	Time (sec.)	q/m (μC/g)			
		Black toner	Cyan toner	Magenta toner	Yellow toner
7 wt%	3	-	14.91	14.15	12.76
	5	-	19.83	24.30	22.02
	10	-	28.44	30.90	28.78
	15	13.16	28.72	31.55	30.17
	30	21.82	30.79	33.35	31.14
	60	27.05	30.88	34.41	31.40
	90	31.76	32.62	34.48	31.88
	120	30.36	32.60	34.88	32.09
	240	32.10	32.72	35.09	32.44
	360	34.26	33.56	36.12	32.60
10 wt%	3	-	10.35	13.00	10.48
	5	-	12.80	16.14	14.00
	10	-	19.68	23.26	17.73
	15	8.61	19.91	25.50	20.56
	30	14.77	20.06	27.32	20.67
	60	17.26	20.33	27.17	20.79
	90	21.07	20.85	27.41	20.80
	120	21.48	20.98	26.73	20.81
	240	24.12	21.04	26.53	21.36
	360	24.26	21.97	26.66	22.48

Table B-2 The q/m values of developer, black toner and three types of carrier, at 800 rpm by MS1 Minishaker

Concentration (wt%)	Time (sec.)	q/m (μC/g)		
		Z-250	TSV-200	F-150
5 wt%	15	24.64	14.97	13.77
	30	28.94	24.67	16.61
	60	31.22	29.77	19.86
	90	33.27	32.51	22.62
	120	34.13	33.20	25.54
	240	34.30	33.80	25.40
	360	36.25	35.83	25.18

Table B-3 The q/m values of developer, black toner and three types of carrier, at 120 rpm by MS1 Minishaker

Concentration (wt%)	Time (min.)	q/m (μC/g)		
		Z-250	TSV-200	F-150
5 wt%	0.5	14.11	13.83	7.70
	1	16.99	14.97	11.81
	2	28.48	22.03	14.38
	5	33.42	30.95	18.51
	10	40.34	38.04	22.53
	15	41.27	38.69	24.75
	20	41.27	39.55	25.86
	30	44.26	40.89	26.33

Table B-4 The q/m values of developer, black toner and TSV-200, at 120 rpm by MS1 Minishaker

Time (min.)	Concentration (wt%)				
	1 wt%	3 wt%	5 wt%	7 wt%	10 wt%
0.5	34.06	21.83	13.83	11.35	6.29
1	44.28	32.00	14.97	11.34	8.53
2	43.53	40.59	22.03	15.95	9.71
5	44.25	39.32	30.95	19.25	12.81
10	45.80	42.87	38.04	24.76	13.58
15	46.78	42.95	38.69	28.79	14.79
20	48.61	42.92	39.55	33.60	16.05
30	47.92	42.94	40.89	37.20	18.92

APPENDIX C

THERMAL PROPERTIES OF TONER

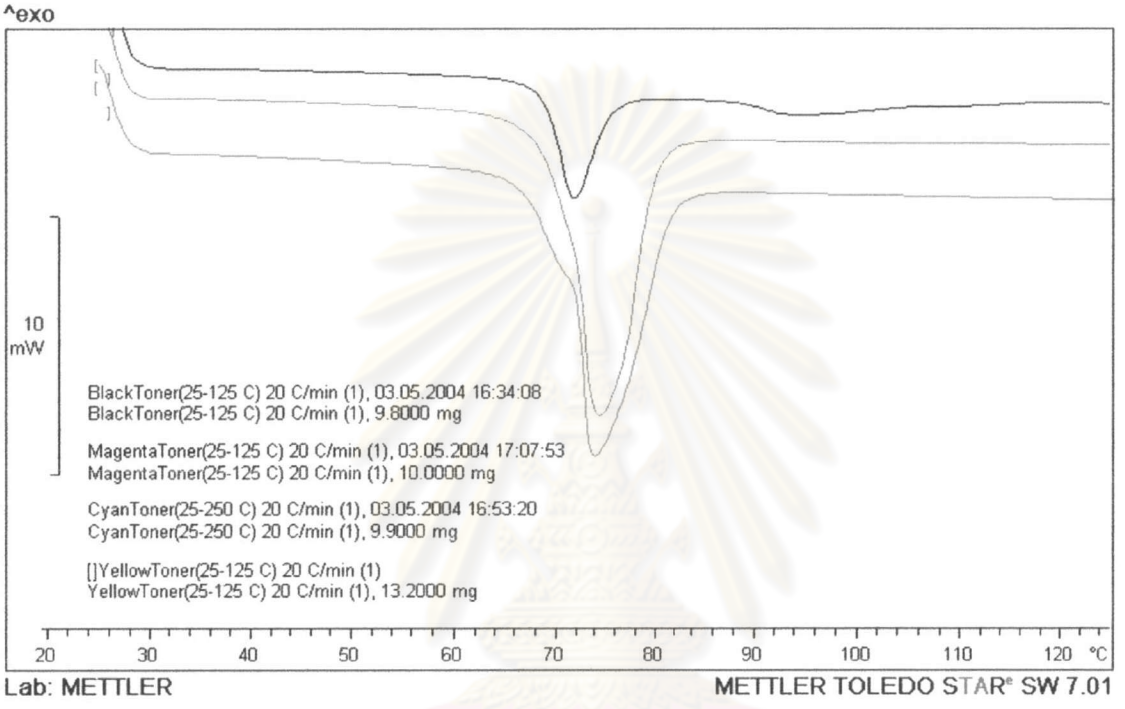


Figure C-1 Thermal properties of four types of toners (black, cyan, magenta and yellow toner) by Differential Scanning Calorimeter, at a heating rate 20°C/min without liquid nitrogen, over a temperature range of 25-125°C

APPENDIX D

THE SPECTRUMS OF FOUR TYPES OF TONERS BY FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR)

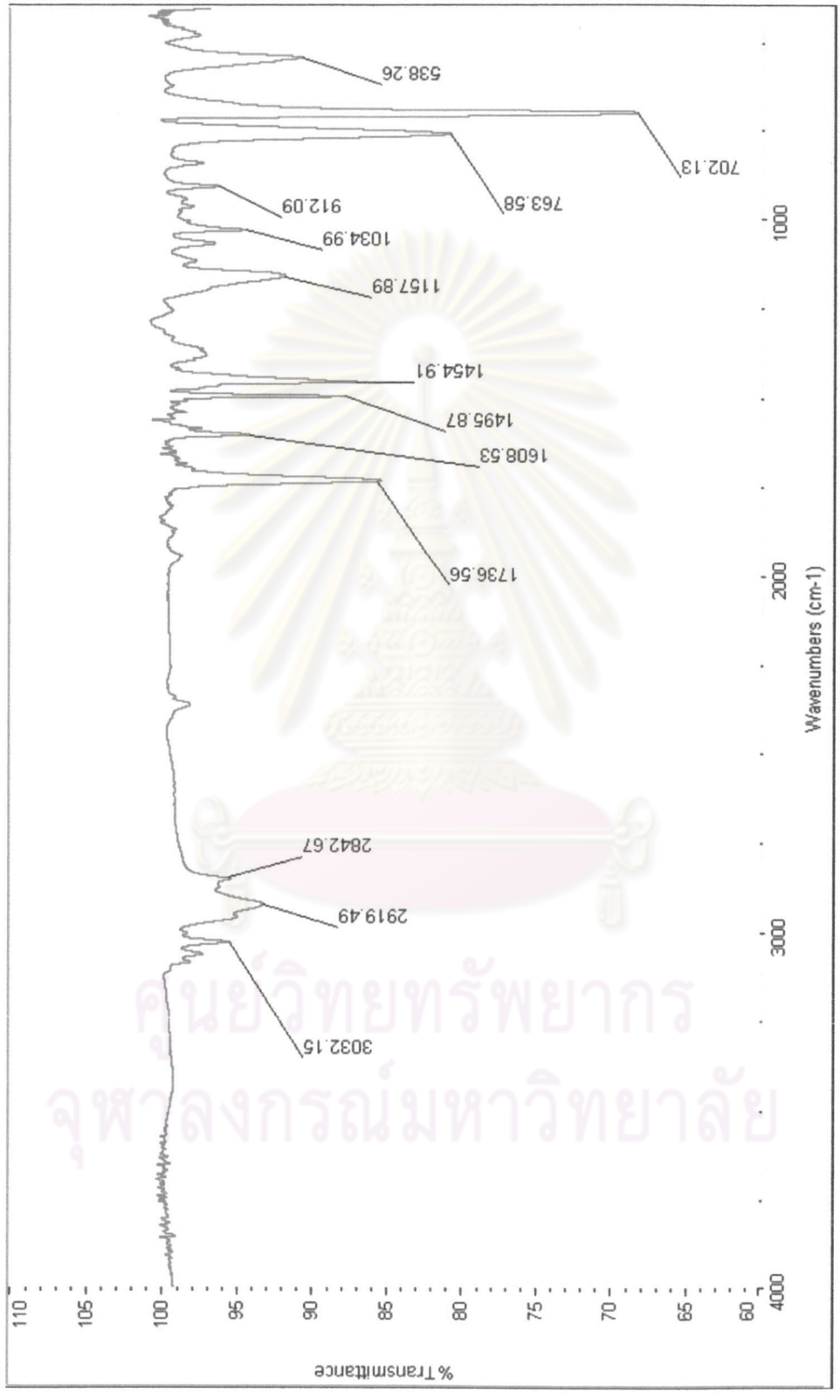


Figure D-1 The spectrums of black toner by Fourier Transform Infrared Spectroscopy (FTIR)

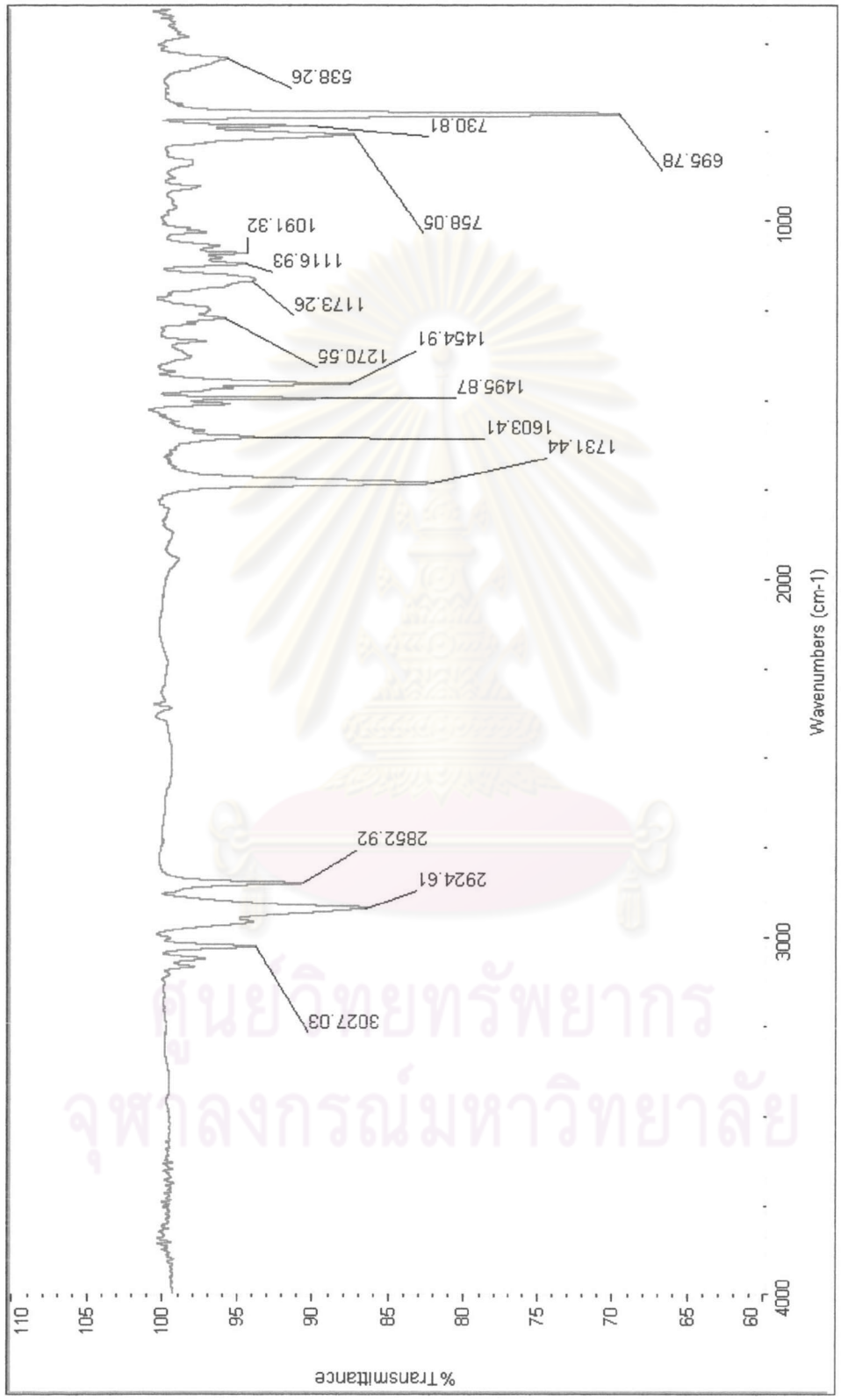


Figure D-2 The spectrums of cyan toner by Fourier Transform Infrared Spectroscopy (FTIR)

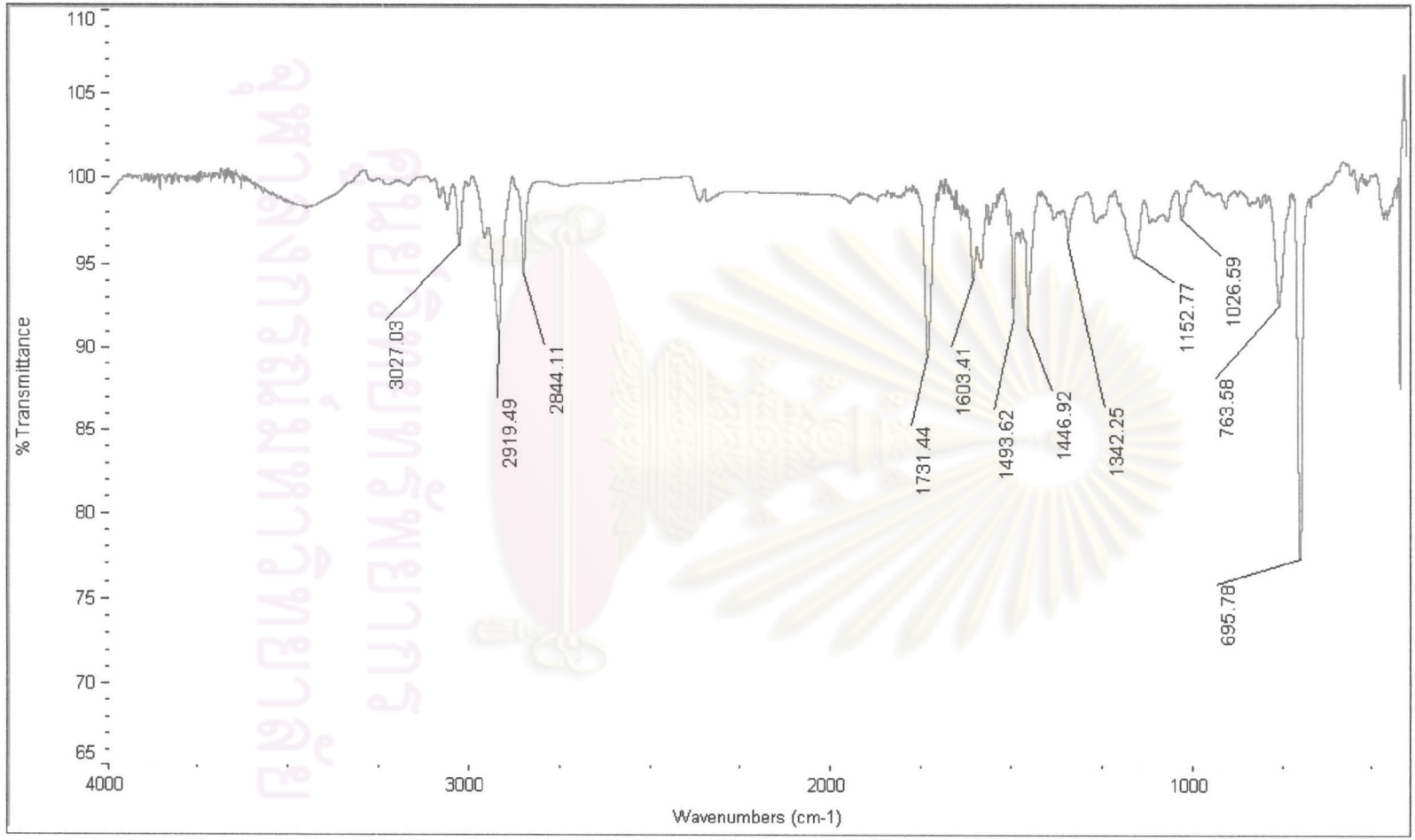


Figure D-3 The spectrums of magenta toner by Fourier Transform Infrared Spectroscopy (FTIR)

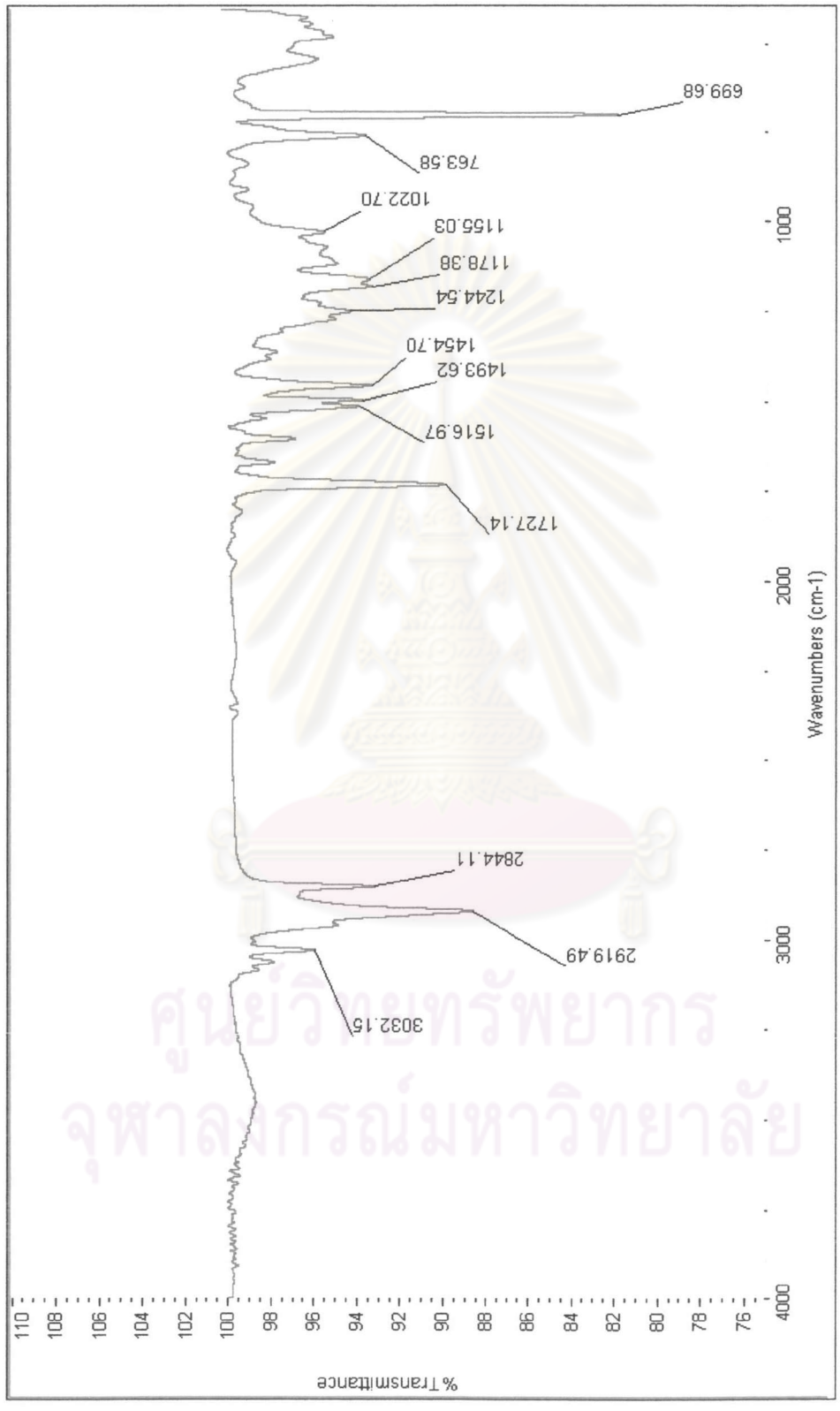


Figure D-4 The spectrums of yellow toner by Fourier Transform Infrared Spectroscopy (FTIR)

APPENDIX E

THE MEASUREMENT OF SOLID DENSITY AND TONE REPRODUCTION

Table E-1 The measurement of solid density for four types of toner from Canon printer by densitometer (Macbeth, RD 915)

Paper	Black toner	Cyan toner	Magenta toner	Yellow toner
1	1.41	0.88	1.11	1.49
2	1.44	0.88	1.16	1.56
3	1.40	0.88	1.14	1.52
4	1.42	0.86	1.11	1.53
5	1.42	0.87	1.14	1.54
6	1.43	0.86	1.10	1.56
7	1.42	0.88	1.12	1.56
8	1.43	0.88	1.12	1.57
9	1.43	0.88	1.11	1.56
10	1.43	0.87	1.09	1.56
11	1.44	0.90	1.11	1.56
12	1.44	0.89	1.10	1.56
13	1.44	0.87	1.09	1.52
14	1.43	0.90	1.13	1.53
15	1.44	0.85	1.09	1.50
16	1.44	0.90	1.11	1.53
17	1.45	0.91	1.13	1.52
18	1.46	0.88	1.12	1.52
19	1.46	0.89	1.11	1.51
20	1.45	0.90	1.13	1.51
Average	**1.43**	**0.88**	**1.12**	**1.54**

Table E-2 The measurement of solid density for four types of toner from Fuji printer by densitometer (Macbeth, RD 915)

Paper	Black toner	Cyan toner	Magenta toner	Yellow toner
1	1.65	1.42	1.39	1.05
2	1.67	1.43	1.41	1.02
3	1.69	1.44	1.36	1.02
4	1.68	1.43	1.39	1.02
5	1.71	1.43	1.43	1.05
6	1.71	1.41	1.36	0.96
7	1.72	1.44	1.43	1.05
8	1.70	1.38	1.36	0.97
9	1.72	1.43	1.42	1.01
10	1.72	1.42	1.41	0.95
11	1.74	1.44	1.46	0.99
12	1.72	1.47	1.43	0.96
13	1.72	1.52	1.41	0.99
14	1.71	1.48	1.44	0.94
15	1.72	1.53	1.45	1.01
16	1.71	1.47	1.45	0.99
17	1.72	1.51	1.44	1.03
18	1.68	1.44	1.34	0.98
19	1.69	1.53	1.40	1.02
20	1.71	1.48	1.42	1.04
Average	**1.70**	**1.46**	**1.41**	**1.00**

Table E-3 The measurement of density at percentage halftone of 0-100 for four types of toner from Canon printer by densitometer (Macbeth, RD 915)

Percentage halftone	Black toner	Cyan toner	Magenta toner	Yellow toner
0	0.09	0.07	0.07	0.07
10	0.17	0.17	0.16	0.13
20	0.25	0.26	0.25	0.22
30	0.33	0.37	0.36	0.36
40	0.44	0.49	0.52	0.58
50	0.57	0.61	0.69	0.83
60	0.72	0.75	0.76	1.03
70	0.88	0.84	0.91	1.54
80	1.09	0.85	1.08	1.56
90	1.31	0.87	1.14	1.54
100	1.43	0.88	1.12	1.54

Table E-4 The measurement of density at percentage halftone of 0-100 for four types of toner from Fuji printer by densitometer (Macbeth, RD 915)

Percentage halftone	Black toner	Cyan toner	Magenta toner	Yellow toner
0	0.09	0.07	0.07	0.07
10	0.21	0.18	0.15	0.17
20	0.28	0.28	0.20	0.23
30	0.37	0.38	0.26	0.30
40	0.46	0.54	0.32	0.37
50	0.56	0.74	0.40	0.43
60	0.71	0.96	0.48	0.53
70	0.89	1.39	0.60	0.61
80	1.11	1.41	0.75	0.70
90	1.32	1.43	0.93	0.84
100	1.70	1.46	1.41	1.00

APPENDIX F

THE L*, a* AND b* VALUES OF TWO SETS OF PRINT-OUTS BY THE SPECTROPHOTOMETER

Table F-1 The measurement of the L*, a* and b* for four types of toner from Canon and Fuji printer by the spectrophotometer (X-Rite SP 62)

Canon			Fuji		
L*	a*	b*	L*	a*	b*
51.33	43.59	-2.07	56.43	49.07	-4.25
47.21	40.95	-6.62	53.75	40.38	-10.41
37.33	19.74	-17.63	47.14	24.96	-19.24
34.90	4.88	-24.23	42.71	6.99	-28.57
35.93	3.00	-25.00	41.09	1.80	-30.77
50.73	44.17	-1.90	57.30	47.95	-5.15
45.47	40.58	-7.27	52.15	41.40	-9.79
36.57	21.36	-17.45	47.69	23.63	-19.76
33.85	6.50	-23.44	41.60	9.68	-26.86
34.60	4.43	-24.35	40.60	2.67	-30.26
50.14	44.91	-1.34	55.09	50.75	-3.63
45.84	40.48	-6.39	52.18	39.01	-10.96
36.72	21.29	-15.60	46.03	25.62	-18.95
34.05	8.04	-22.70	42.55	10.34	-26.71
34.47	4.17	-22.67	40.08	2.83	-29.80
51.67	46.02	21.59	51.32	53.09	6.85
46.62	40.35	13.20	48.09	40.39	1.06
38.42	22.55	-0.63	42.14	27.20	-6.17
30.70	11.73	-9.06	39.00	12.87	-14.47
32.02	2.68	-15.51	36.87	2.51	-18.99
51.25	49.65	33.46	49.05	51.40	22.11
46.69	38.45	25.14	45.16	39.08	14.83
38.42	21.14	14.26	40.64	23.53	9.16
32.60	8.58	5.58	34.43	12.08	4.40
27.84	0.23	-0.90	34.87	-1.61	-0.61
92.89	-0.37	0.85	92.58	-0.33	1.00
82.56	-9.47	-4.59	81.80	-8.15	-12.55
67.89	-21.54	-16.45	72.70	-18.05	-24.40
59.18	-27.36	-22.17	60.69	-24.80	-36.54
58.39	-26.63	-23.93	59.31	-25.08	-37.49
90.57	-5.42	19.57	88.12	-0.20	14.25
77.88	-14.20	9.67	79.49	-10.57	3.06

Canon			Fuji		
L*	a*	b*	L*	a*	b*
66.84	-25.87	-4.09	71.25	-21.26	-8.45
57.72	-34.19	-8.90	58.19	-32.77	-20.16
57.00	-31.84	-14.41	56.98	-32.83	-21.88
89.17	-10.63	61.42	86.99	-1.50	28.75
80.06	-18.11	42.92	79.21	-12.34	19.11
64.62	-32.26	25.24	71.89	-23.98	11.73
57.18	-39.54	19.31	59.05	-36.36	2.37
53.11	-39.18	15.74	54.82	-38.23	1.33
88.25	-10.99	77.45	87.04	-4.12	45.23
77.63	-19.87	65.29	81.88	-15.61	40.09
65.63	-30.90	46.02	73.04	-25.01	31.27
57.28	-38.70	31.21	61.36	-34.07	19.68
54.79	-38.54	25.17	54.83	-38.62	12.46
87.76	-12.31	77.12	88.51	-7.18	57.99
77.33	-20.58	63.90	81.51	-15.68	50.64
65.77	-30.63	44.96	72.67	-25.10	39.08
57.77	-38.12	31.23	60.13	-35.71	21.06
54.93	-37.91	23.01	53.74	-39.49	13.20
63.22	35.12	-5.63	76.51	21.05	-5.18
60.80	28.34	-11.82	70.23	11.61	-13.63
62.82	-4.52	-23.02	63.38	-1.49	-23.24
53.70	-19.20	-30.36	55.54	-16.23	-34.80
53.09	-18.50	-30.93	52.94	-19.13	-37.93
51.66	45.04	-4.46	66.39	34.86	-6.55
48.14	41.96	-9.65	61.01	26.52	-13.32
43.82	21.07	-23.47	55.18	12.52	-22.32
42.60	0.24	-32.03	49.24	-1.81	-31.22
40.82	-3.30	-30.43	46.82	-9.33	-35.29
78.12	4.83	65.60	77.67	7.42	58.34
77.93	-12.01	67.35	74.71	-5.63	46.83
66.06	-29.86	46.75	73.19	-24.67	39.43
57.49	-38.29	32.72	60.43	-35.26	21.22
53.79	-38.15	23.60	53.68	-39.60	11.32
61.47	32.41	48.36	68.10	21.82	47.30
61.50	15.91	48.62	64.43	8.10	41.27
61.36	-12.27	44.64	61.20	-7.06	31.07
55.45	-32.27	31.58	58.28	-25.29	20.25
53.03	-37.88	22.52	53.58	-39.41	10.41
51.51	50.68	37.43	58.99	36.30	34.59
48.42	37.80	30.59	54.46	22.58	26.59
43.81	14.86	22.09	48.78	10.80	20.63
42.50	-6.34	20.68	44.51	-4.41	12.61
42.01	-22.77	10.09	43.08	-26.29	6.51
92.68	-0.30	0.81	92.60	-0.38	0.99

Canon			Fuji		
L*	a*	b*	L*	a*	b*
27.98	0.87	-1.29	34.88	-0.58	-1.69
81.24	12.95	3.62	81.99	10.15	6.07
79.11	8.14	31.99	79.79	8.91	22.01
77.14	6.76	61.47	77.47	9.22	38.13
64.43	35.25	-2.65	76.22	20.44	-2.64
65.07	34.63	6.73	72.90	20.49	12.16
62.22	32.44	37.04	69.66	21.50	29.33
50.98	44.49	-3.87	65.95	35.42	-6.34
52.38	47.43	2.17	64.35	35.83	-0.56
53.01	49.16	25.71	60.65	36.77	18.11
58.27	-27.76	-20.95	58.50	-28.47	-30.24
54.69	-39.43	10.55	56.70	-36.76	-7.23
54.65	-38.01	25.00	54.22	-39.48	10.61
53.09	-20.39	-29.83	53.51	-19.75	-37.77
53.60	-30.20	-15.91	53.74	-29.70	-18.95
51.58	-37.27	15.82	53.91	-39.37	6.08
42.56	-5.80	-30.60	47.49	-10.97	-35.79
42.88	-10.59	-26.53	46.79	-14.23	-29.85
41.34	-22.78	-3.13	43.55	-21.17	-11.71
79.81	14.09	-3.47	84.14	10.40	-2.66
80.34	-0.02	-8.24	77.37	-0.77	-12.95
66.92	-18.04	-18.08	69.25	-13.96	-24.65
58.92	-26.64	-21.80	60.11	-24.89	-36.98
58.29	-24.89	-25.29	59.21	-24.85	-37.59
92.88	-0.50	0.80	92.51	-0.41	0.98
87.54	-3.58	-3.40	86.94	-4.28	-6.16
82.83	-7.22	-5.28	83.00	-7.81	-11.17
77.54	-11.25	-8.32	79.39	-11.41	-15.62
73.38	-15.36	-11.24	74.36	-15.55	-21.80
70.44	-18.88	-13.48	69.61	-20.36	-27.78
66.02	-22.43	-17.95	64.98	-23.05	-32.28
64.13	-24.55	-20.05	58.62	-24.84	-38.05
64.10	-24.44	-20.39	58.17	-24.86	-38.30
62.86	-23.57	-21.58	58.00	-24.86	-38.29
62.05	-22.52	-22.82	57.84	-24.72	-38.57
92.87	-0.39	0.92	92.44	-0.40	0.97
88.14	5.81	0.02	87.84	5.74	-1.36
83.06	12.09	0.44	85.11	9.24	-2.41
77.45	19.62	-0.10	82.28	13.02	-3.37
70.87	28.36	-1.02	79.06	17.32	-4.40
64.76	35.90	-1.28	75.89	21.71	-5.36
62.49	37.96	-2.01	72.46	26.24	-5.80
58.06	42.08	-2.29	67.87	32.63	-6.20
53.60	46.12	-2.65	63.47	38.92	-6.26

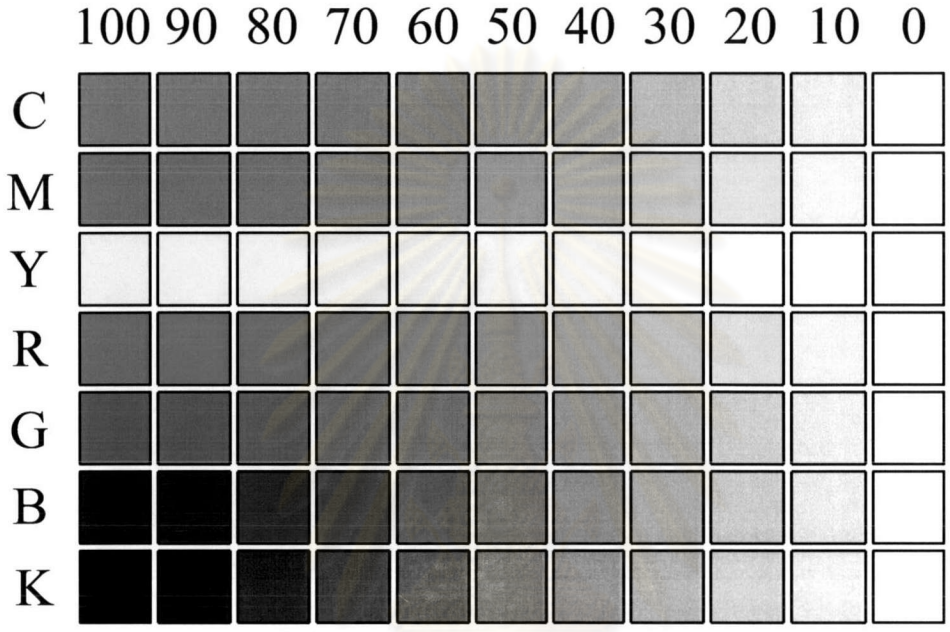
Canon			Fuji		
L*	a*	b*	L*	a*	b*
52.18	47.16	-1.69	58.91	45.23	-5.31
52.57	45.62	0.68	52.05	54.38	-1.47
92.92	-0.47	0.89	92.46	-0.40	0.95
92.49	-2.68	8.22	89.83	0.29	8.46
92.05	-4.73	16.23	89.34	-0.54	13.27
91.37	-7.41	28.85	87.96	-0.32	18.67
90.57	-9.94	45.40	87.63	-1.18	24.11
89.98	-11.26	59.13	87.22	-1.63	28.68
89.56	-11.77	70.40	87.13	-2.86	35.81
88.95	-11.40	85.87	87.57	-4.36	42.96
88.98	-11.42	85.83	89.09	-7.20	51.70
89.02	-11.68	84.52	88.70	-7.21	58.56
88.71	-11.99	84.38	88.18	-7.02	65.83
92.89	-0.42	0.86	92.49	-0.41	0.93
88.12	3.66	5.86	86.69	4.56	6.41
83.17	8.24	11.28	82.80	7.87	11.00
76.73	15.14	17.20	78.66	12.02	15.12
69.04	24.89	22.90	74.59	16.71	17.85
62.77	33.97	25.11	69.51	22.98	21.86
58.36	41.57	23.40	64.22	30.47	23.07
53.74	48.63	26.57	60.62	35.27	26.11
50.97	52.38	31.76	56.50	41.12	27.73
50.74	52.64	32.63	50.86	49.27	25.72
50.81	50.41	32.93	45.30	51.68	23.54
92.90	-0.46	0.86	92.48	-0.40	0.91
86.75	-5.39	4.19	85.83	-4.17	1.58
81.66	-11.09	9.62	81.43	-8.22	1.78
76.55	-17.08	14.72	78.50	-12.30	3.75
71.09	-24.02	20.39	75.07	-17.99	6.01
67.85	-28.33	23.13	71.00	-23.10	6.08
63.67	-33.26	23.49	67.47	-29.98	6.85
60.67	-37.02	25.80	63.17	-33.23	7.82
57.46	-38.14	23.72	55.11	-38.28	4.66
55.42	-37.26	21.23	53.22	-39.72	7.89
53.68	-36.90	21.19	52.51	-40.05	9.68
92.85	-0.45	0.93	92.50	-0.40	0.93
85.68	1.78	-2.23	83.68	1.05	-6.83
79.49	3.67	-5.79	77.97	1.43	-11.57
73.20	5.83	-9.83	71.98	2.28	-15.76
66.36	7.71	-14.00	66.83	2.74	-19.10
59.56	9.73	-18.12	60.54	2.36	-23.91
53.80	9.47	-21.68	55.06	3.39	-26.48
46.37	9.38	-26.42	50.18	3.30	-28.69
41.93	4.70	-29.18	46.34	4.58	-29.50

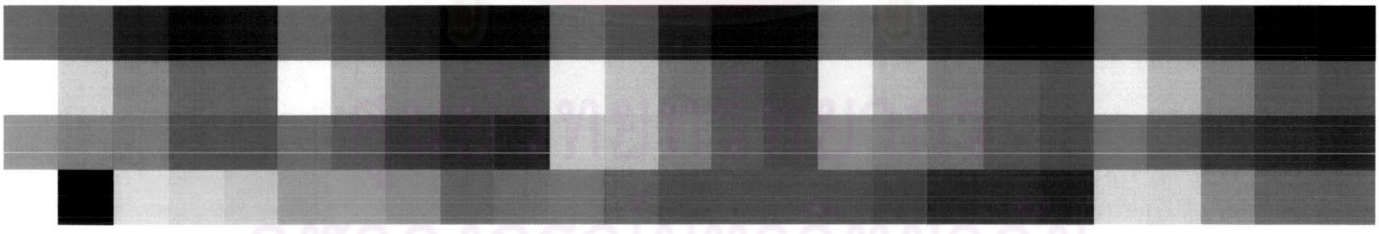
Canon			Fuji		
L*	a*	b*	L*	a*	b*
36.02	-0.27	-24.81	42.02	4.11	-30.04
34.89	0.27	-23.51	38.59	3.64	-29.48
92.85	-0.46	0.90	92.49	-0.39	0.90
87.02	-0.40	0.83	83.66	-0.10	1.38
81.35	-0.32	0.70	80.00	-0.59	-1.47
75.16	-0.30	0.56	74.38	-1.36	-3.19
68.83	-0.29	0.54	69.63	-2.42	-3.19
61.95	-0.19	0.37	64.34	-2.64	-2.31
53.76	-0.11	0.05	57.90	-2.92	-4.89
46.46	-0.03	-0.02	51.36	-2.22	-6.28
38.53	0.03	-0.09	45.09	-0.20	-6.31
31.83	0.08	-0.09	35.07	0.78	2.03
28.62	0.16	-0.13	33.06	-0.65	-1.07

APPENDIX G

THE PRINT-OUTS

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
a b c d e f g h i j k l m n o p q r s t u v w x y z





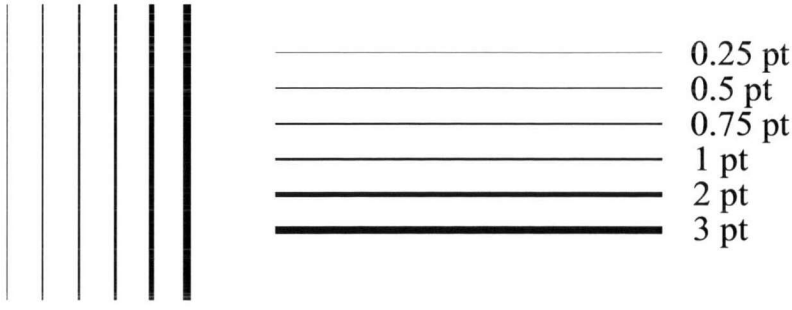
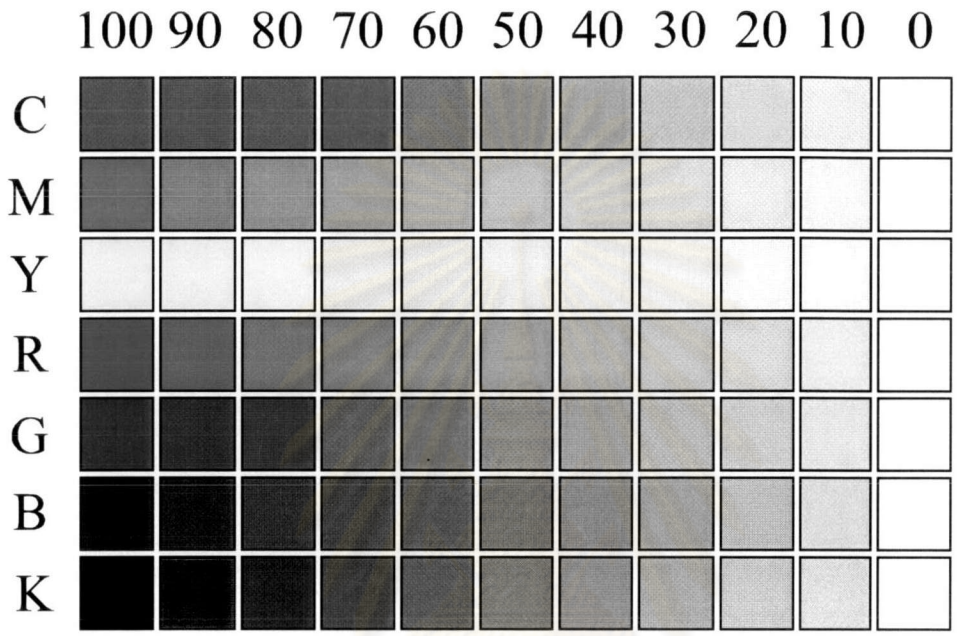
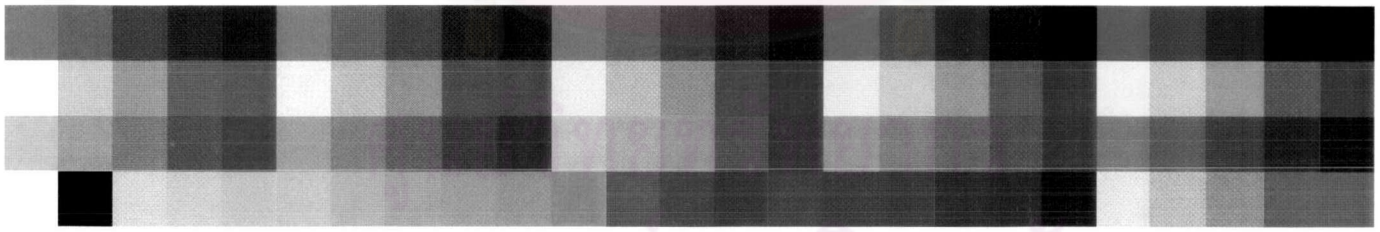


Figure G-1 The print-out from Canon printer (polymerized toner)

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
a b c d e f g h i j k l m n o p q r s t u v w x y z





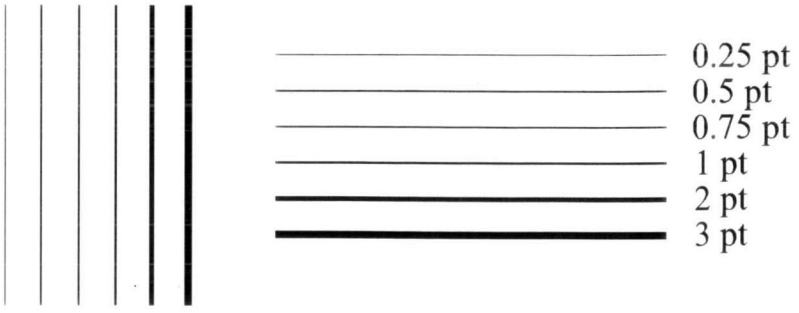


Figure G-2 The print-out from Fuji printer (pulverized toner)

VITA

Miss Patama Somboonpanya was born on February 7, 1980 in Bangkok, Thailand. She received her Bachelor Degree of Science in Photographic Science and Printing Technology, from Chulalongkorn University in 2002. She has perused Master Degree of Science in Imaging Technology, Graduate School, Chulalongkorn University since 2002 and finished her study in 2005.