CHAPTER III

EXPERIMENTAL

3.1 Materials and Chemical

3.1.1 Dye Based Inks

WATER BLUE 9, Orient Chemical industries, Osaka, Japan

C.I. Acid Blue 9

Chemical Class: Triphenylmethane

Solubility in water >30.0 %

WATER RED 27, Orient Chemical industries, Osaka, Japan

C.I. Acid Red 52

Chemical Class: Xanthene

Solubility in water 7.5%

WATER YELLOW 1, Orient Chemical industries, Osaka, Japan

C.I. Acid Yellow 23

Chemical Class: Monoazo

Solubility in water 7.5%

WATER BLACK R510, Orient Chemical industries, Osaka, Japan

C.I. Acid Black 2

Chemical Class: Azine

Solubility in water 7.5%

3.1.2 Other Chemical

Diethylene glycol: ($C_4H_{10}O_3$) from Fluka Chemie AG CH-9471 Buchs, Switzerland

Analytical grade, M = 106.12 g mol^{-1}

Glycerin: ($C_3H_8O_3$) from Merck, Darmstadt, Germany

Analytical grade, M = 92.10 g mol^{-1}

Urea: (CH_4N_2O) from AJAX, New South Wales, Australia

Analytical grade, M = 60.06 g mol^{-1}

Fabrics: four types of silk Fabrics from the Thai Silk Company Limited, Bangkok, Thailand

3.2 Equipment

3.2.1 Inkjet Printer: Canon BJF-8500, Canon Inc., Tokyo, Japan

3.2.2 Viscometer: Brookfield DV III Programmable Rheometer/TC500, Brookfield Engineering Laboratories, Inc., Stoughton, USA

3.2.3 Surface tensiometer: K 810, Kruss, Hamburg, Germany

3.2.4 pH meter: SA 720, Orion Research Incorporation, Boston, USA

3.2.5 Mechanical stirrer: RE 16, IKA-Labortechnix, Staufen, Germany

3.2.6 Spectrophotometer: Gretag-Macbeth AG, Rogensdorf, Switzerland

3.2.7 Image analyzer: LUZEX F, PM 10-AD, Olympus, Nireco Corporation, Tokyo, Japan

3.2.8 Microdensitometer: PDM-7, KONICA, Tokyo, Japan

3.2.9 Glossmeter: Micro Sheen 250, Surrey, London, England

3.2.10 Densitometer: Gretag D200-II, Rogensdorf, Switzerland

3.3 Procedure

3.3.1 Inkjet Ink

3.3.1.1 Preparation of Inkjet Inks

The ink components were weighed proportionally, in which the deionized water, main solvent, diethylene glycol, glycerin, urea and colorant were mixed. The mixture was then stirred to be a homogeneous solution. Then, acetic acid was added to control the ink pH in a range of 5.2-6.2. The inks were later filtered through 400 mesh nylon screen for eliminating particles and preventing clogging problems. A set of inks contained four colors, which have cyan, magenta, yellow, and black. Then the inks were stored in a dessicator which was connected to a suction pump for eliminating any air bubbles. Then the four colors of inkjet ink were filled into the ink tanks of the printer. The formulation of inkjet inks is shown in Table 3.1.

Table 3.1 Formulation of Inkjet Inks

Composition	**Concentration (%wt)**
Dye	5.0
Diethylene glycol	10.0
Glycerine	10.0
Urea	5.0
Deionized water	70.0
Total	**100.0**

3.3.1.2 Characterization of Inkjet Ink

The inkjet inks were measured for their viscosity by Brookfield viscometer DVIII Programmable Rheometer, with a spindle number 31 at the temperature of 25°C under many shear rates. The range of the shear rates was from 50 to 250 rpm.

3.3.2 Silk Fabrics

3.3.2.1 Preparation Silk Fabric

Four degummed and no bleached silk fabrics were washed with soap, then cleansed with water and dried at ambient atmosphere.

3.3.2.2 Backing of Fabrics

In order to print textile substrates, it is necessary to assure correct and straight transportation of fabric stability in the printer feed rollers. Deformation of the fabric was prevented by applying a transparency film or plastic film, which has a flat surface and should have a uniform-thickness strip of masking tape to the back of the fabric.

3.3.2.3 Characteristic of Silks

a. Number of yarns per unit length

The number of yarns per unit length of silk fabrics was picked counter from the number of weft and warp yarns per unit length in each direction.

b. Yarn number

The yarn number of fabrics was measured a simple test method defined in ASTM D 1059-76. The sample is testing in standard atmosphere. In removing ends from woven fabric, take care to choose samples believed to be representative of each type of yarn present in the fabric. The silk fabrics take samples

1 m long and take ten specimens from the warp [15]. The yarn number calculated through the following equation 3.1:

$$\text{Yarn Number} = \frac{(G \times F)}{(1 + C)M} \qquad (3.1)$$

where G = mass of conditioned yarn, g

F = constant for the various direct systems: Denier is 9000.

C = change in length per unit length of yarn in untwisting

M = length of the specimen, m

c. Texture

The texture of silk fabrics was evaluated using the transmission images by Image analyzer.

d. Wicking Test

Wicking of silk fabrics was evaluated from INDA IST 10.0-70 Method 10.3 for non-woven fabrics. Two sets of fabric samples of 25 mm wide and 305 mm long were prepared. One set of samples was cut in the warp direction and the other in the weft direction. During the test, each fabric strip was positioned vertically over the glass beaker containing several fluids, and end of the fabric was immersed in the fluid for 5 minute. The tests were conducted in both distilled water (W) and 2-octanol (O). The ratio of these two measurements, the wicking ratio (W/O), was used as an indicator of the hydrophilic vs. hydrophobic nature of the silk fabrics.

e. Gloss

The non-printed silk fabrics were measured for gloss at 60° by glossmeter (Micro Sheen 250, Surrey, London, England). The gloss was measured three times to give an average value.

3.3.3 Modulation Transfer Function (MTF)

3.3.3.1. Reflection Density

Sinusoidal Test pattern contact method was used in this research. A sinusoidal test pattern glass used is NT54-803 by Edmund optical, where a variable transmission type pattern made on exceptionally high resolution film sandwiched in soda lime glass. The sinusoidal test pattern arrays used for each sample silk fabric have spatial frequencies 0.375, 0.5, 0.75, 1.0, 1.5, 2.0, 2.5 and 3.0 cycles/mm. It was contacted onto the sample silk fabric and this reflection intensity distribution was measured with a microdensitometer (KONICA, PDM-7). The measurement was on the warp direction. The data recorded in a form of reflection density, reflectance could then be obtained by equation 3.2.

$$Ro = 10^{-Dr} \tag{3.2}$$

where Ro is reflectance and Dr is reflection density. This reflectance corresponded to intensity of the output sinusoidal image.

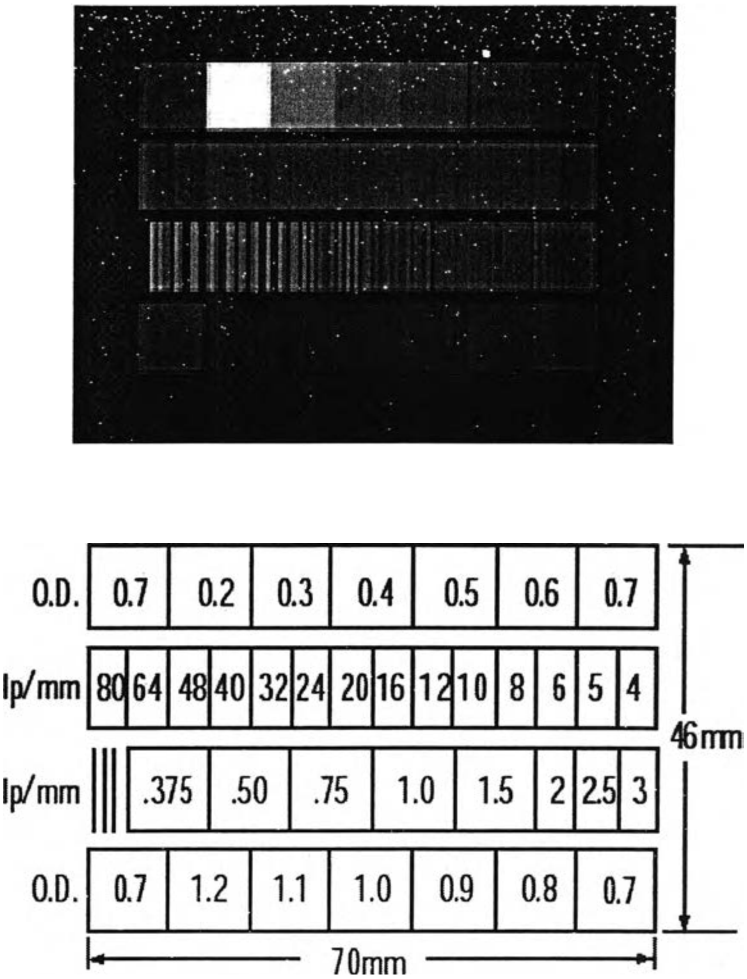

Fig 3.1 Sinusoidal target type transmittance from Edmund optical

3.3.3.2. Fast Fourier Transforms (FFT)

The reflectance data will be computed for frequency domain by the FFT technique in the Matlab program. The equation 2.1 will be applied for analysis of the signal and noise in a frequency domain. After that, the select signal of silk fabrics was measured by the low pass filtering technique. Finally, the IFFT (Invert Fast Fourier Transforms) technique was used for converting to the reflectance data as Figure 3.2.

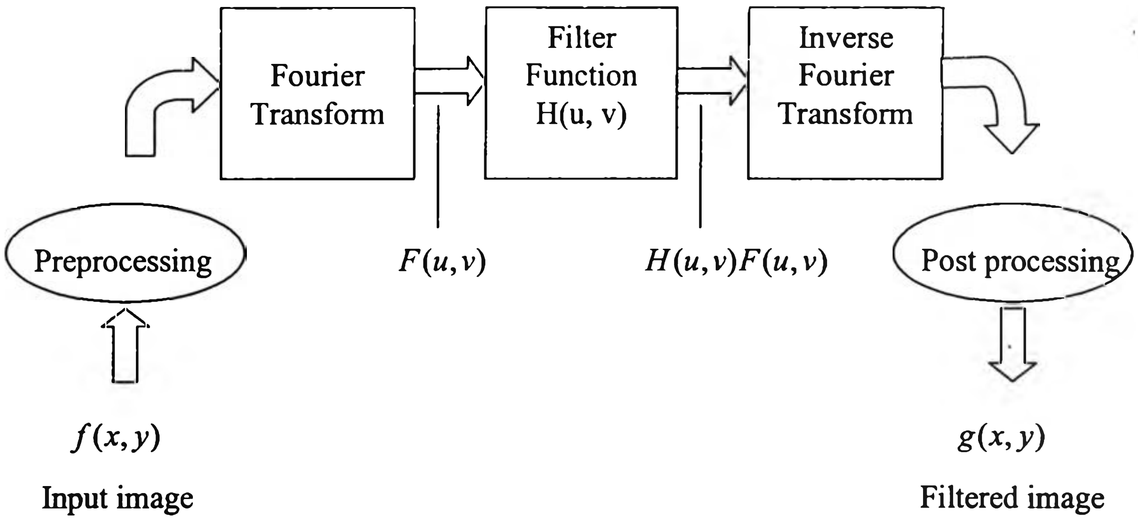

Figure 3.2 Frequency domain filtering operations

3.3.3.3. Conversion of CTF data to MTF

Since the MTF of silk fabric can be calculated by the CTF of print. The MTF of silk can be computed by the CTF of print and vice versa, as

$$MTF_{silk}(\omega) = 2 \bullet CTF_{print}(\omega) - 1 \qquad (3.3)$$

The data from 3.3.3.2 for each spatial frequency were computed by eq. (3.4).

$$c(\omega) = i_{max} - i_{min} \qquad (3.4)$$

where ω denotes the spatial frequency, and i_{max} and i_{min} denote the maximum and minimum intensities of the output.

The CTF of print can be calculated by eq. (3.5).

$$CTF_{print}(\omega) = c(\omega)/c(0) \qquad (3.5)$$

3.3.4 Yule-Nielsen Model

The film was prepared, which contained 0, 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90 and 100 percent dot area. It was contacted onto the silk fabric and the fabric density was measured with a densitometer (Gretag D200-II). The relationship between the percent dot area and density of film on the silk was plotted. The data plotted in a form of the transmitting density, compared with Yule-Nielsen model could be obtained by equation 3.6.

$$D = -n\log\{1 - A[1 - 10^{-D_s/n}]\} \qquad 3.6$$

where n is Yule-Nielsen value for fitting the data. D_s is the optical density of the solid area coverage. A is weighed by the dot area coverage.

3.3.5 Characteristics of the Printed Silk Fabrics

Cyan, magenta, yellow, and black inks were printed on the silk fabrics using a BJF-8500, Canon printer. The printer was calibrated according to the manufacture instruction. The QAE test chart was printed to the four silk fabrics. The print quality analyzed quantitatively was line quality.