CHAPTER 1

INTRODUCTION

1.1 Scientific Rationale

Textile ink jet printing emerges as creative technology, environmentally friendly, photorealistic printing, scanned patterns with no design limitation, short-run order, affordable price, customized production with average speed of 2 m^2/min and economical printing process in the advantages of no need for screens. Pigments have many inherent advantages over dyes as inkjet colorants. In printing applications that require permanence properties, such as water fastness, light fastness, and rub resistance, pigmented colorants are preferred. The cost of pigmented ink printing is lower than that of dye-based ink. The inks made from the surface-modified pigment had a low viscosity and high surface tension because of a low dispersant content; moreover, this technique yielded high optical density, good tone reproduction, better color gamut, and gamut volume. The surface modified dispersion relates to chemical bonding and the number of functional groups of the pigmented surface. These technique leads to well characterize pure pigments, void of free polymers and impurities.

Textile which is directly printed with ink jet printer, does not provide the high quality printing because the surface of the silk fabric is not smooth like paper. The pretreatment process is necessary for the inkjet textile printing because the fabric is porous, soft and pliable; thus, the fabric needs to be pretreated. The pretreatment limits the excess spreading of inks. The chemical on the fabric helps smoothing on the

fabric surface. The ink absorption is thus more uniform. Moreover, the functional groups of the pretreated compounds are expected to adsorb additional ink, resulting in a better fixation of ink on the fabric. The pre-treating solutions contain many functional groups to fix the ink molecules on the surface of fabric; thus, the ink penetration speed becomes slow and gives the higher color strength. Amino compound was used to pretreat the silk fabric because this chemical is compatible with silk fibers in which amino acid was observed. Print quality in inkjet printing is strongly dependent on the interactions between the ink and the media. Print quality of the fibrous structure of textiles requires further research; a thorough understanding of ink-fabric interactions and their effects on print quality remains a widely open field for both academic and industrial research. Hydrophilic coated and laminated fabrics transmit water vapor selectively by a molecular process, i.e., by absorption, diffusion, and desorption through the solid polymer layer. Such a polymer film or coating shows no evidence of voids or microporous structure, and thus is not susceptible to surface contamination by dirt, dust, etc. [1]

Silk has had a reputation as a luxurious and sensuous fabric, one associated with wealth and success. Silk is one of the oldest textile fibers known to man. Silk is yet another word for elegance, and silk garments are prized for their versatility, wear ability and comfort. Silk is the strongest natural fiber. Silk is a fine continuous monofilament fiber of high luster and strength and highly valued as a prestige fiber. A steel filament of the same diameter as silk will break before a filament of silk. Silk absorbs moisture, which makes it cool in the summer and warm in the winter. Because of its high absorbency, it is easily dyed in many deep colors. Silk retains its shape, drapes well, caresses the figure, and shimmers with a luster at its own. Silk

may yellow and fade with the use of a high iron setting. Press cloths and a steam iron are recommended. Silk is also weakened by sunlight and perspiration.

Chitosan is produced commercially by deacetylation of chitin (can be produced from chitin also), which is the structural element in the exoskeleton of crustaceans (crabs, shrimp, etc.). The amino group in chitosan has a pKa value of ~6.5, thus, chitosan is positively charged and soluble in acidic to neutral solution with a charge density dependent on pH and the %DA-value. In other words, chitosan is bio-adhesive and readily binds to negatively charged surfaces such as mucosal membranes. Chitosan enhances the transport of polar drugs across epithelial surfaces, and is biocompatible and biodegradable. Purified qualities of chitosan are available for biomedical applications [2]. Dyeing of the chitosan treated cotton occurred between prorogated amino groups and suffocates acid groups on the dye ions. This interaction forms an insoluble chitosan/dye product which remains in the solution. Chitosan improves the dye coverage of immature fibers in cotton dyeing [3] and that it could be successfully used as a thickener and binder in pigment printing of cotton [4]. The carboxyl and amino groups of amino acids are ionized in solution at neutral physiological pH, with the carboxyl group bearing a negative charge ($-COO^-$) and the amino group a positive charge ($-NH_3^+$). A cationic moiety of amino acid improves the ink adsorption containing the negative charge.

The main objectives of the research are to study the effect of pretreated compounds on the quality of silk fabrics printed by inkjet printing, and also to investigate the concentrations of pretreated solutions versus the quality of printed silk fabrics via physical properties and color gamut. The pretreated compounds used in

this study mostly contain amino groups in the structures, such as amino acids, silk sericin, and chitosan [5 - 8].

1.2 Objectives of the research work

The objectives of this research are as follows:

1.2.1 To study the properties and stability of pigment ink jet inks.

1.2.2 To study the effect of pretreated compounds on the physical and chemical properties of printed silk fabrics.

1.2.3 To investigate the effective concentrations of the pretreated compounds via physical properties and color gamut of printed silk fabrics.

1.2.4 To obtain the relationship between depth of the ink absorption and the pretreatment compounds.

1.3 Expected Benefit Obtainable from the Development of This Research

1.3.1 Developed the pigmented ink jet inks.

1.3.2 Enhanced the ink absorption on amino compound pretreated fabrics.

1.3.3 Improved the quality of the Thai silk fabric.

1.3.4 Obtained the high quality of printed silk fabric.

1.4 Scope of the research work

This research focuses on the pretreatment on silk fabric since the pretreatment on the fabric helps smoothing the fabric surface. The ink absorption is thus more uniform. Moreover, the functional groups of the pretreated compounds are expected to absorb additional ink, resulting in a better fixation of ink on the fabric. The pretreated solutions were aspartic acid, serine, glycine, sericin, chitosan, and Sanfix

555. The silk fabrics were bleached to improve the whiteness before treating and printing. The untreated and treated fabrics were printed with home-made pigmented inkjet inks. The prepared inks were examined viscosity, surface tension, pH, particle size distribution, zeta-potential, Scanning Electron Microscopy (SEM) and Transmission Electron Microscope (TEM). The pretreated fabrics were studied for wicking, Scanning Electron Microscopy (SEM), Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR) and Raman spectroscopy. After printing, the untreated and the treated fabrics were studied for the ink absorption, color gamut, air permeability, stiffness, dry/wet crock fastness and wash fastness.

1.5 Content of the research work

This thesis consists of 5 chapters including introduction, theoretical background and literature review, experimental, results and discussion, and conclusions and suggestion. Chapter 1 describes the introduction of the thesis, scientific rationale, scope of the work and expected benefits obtained from the thesis. Chapter 2 displays a brief of the inkjet printing, the ink system, the dispersion technologies in pigmented inkjet inks, a brief of pretreatment, amino acid and protein, sericin, chitosan, a brief of textile printing, silk fibers and their properties, textile testing and the brief literature review of some previous reports. In Chapter 3, the details about the materials, apparatus and procedure of this research are explained. Chapter 4 presents the results and discussion of the ink properties, stability of the inks, the chemical properties of the pretreated fabrics, physical properties of the printed silk fabrics on the various fabrics. Chapter 5 concludes the outcome of the research and some suggestions for further work.