# CHAPTER 1

# INTRODUCTION

## 1.1 Scientific rationale

Textile ink jet printing technology has been continuously developed. Nowadays, textile ink jet printing using digital technology is similar to paper ink jet printing and can replace screen printing. Ink jet printing will become an important technology in printing of textile because it offers a simple process, environmentally friendly, photorealistic printing, scanned patterns with no design limitation, short-run order, affordable price, customized production with average speed of 2 $m^2$ $min^{-1}$, and economical printing process but the disadvantages have been obtained on color print quality, flexibility of printing inks, and ink clogging the orifice of the printer. However, the textile printing system is becoming popular in the market of textile printing since the ink of ink jet process can be transferred directly onto the substrate. Inks for fabric printing are usually classified into two categories: dye-based and pigment-based. To achieve the highest image quality applications, dye-based inks has been preferred, but for signage applications where durability, especially light fastness, smear fastness and water fastness are required. Thus, the pigmented inks have gained a very popular option. Pigment system is the most rapidly growing area of the textile printing. The most important requirement of pigmented inks is the pigment dispersion over a wide range of temperatures and times. Moreover, if the size of pigments and binders in the inks are small, the clogging may be reduced. Fabric ink jet printing makes use of the pigmented inks with the nanoscale microemulsion latex particles as binders and commercial pigment dispersions demonstrated excellent printability of the inks, and good color fastness and softness of the printed fabrics [1].

The binder of ink jet ink may contain one or more polymers. It controls the viscosity of the system and promotes droplet formation. The polymer also serves to bind the colorant and provide the adhesion to the surface [2]. The binder is a polymer capable of film formation such as an acrylic resin, and it may be added to the formulation as a water soluble type or in an emulsion/dispersion form. The binder provides adhesion of the dye or pigment to the substrate by forming a film [3]. In formulation of inks, pigments must form firm bonding with fibrous substrates with the aid of water dispersed binder. A good binder suitable for ink jet inks remains a great challenge so far due to a lot of strict requirement for particle size, size distribution, surface tension, viscosity, stability, compatibility with other components of the inks and the printer and wettability with the printed fabric. A nanoscale binder is suitable for pigment-based ink jet ink printing on fabrics. Since fabric ink jet printing with the nanoscale binder and commercial pigment dispersions demonstrates excellent printability of the inks and good color fastness and softness of the printed fabrics [1].

The pretreatment process is necessary for the ink jet 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 deposited on the fabric helps smooth the fabric surface. The ink absorption is more uniform. Moreover, the functional groups of the pretreated compounds are expected to adsorb additional ink, resulting in a better reception 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. Print quality in ink jet printing is strongly dependent on the interactions between the ink and the media. This research uses chitosan, 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 dependence on pH and the %degree of deacetylation (%DA)-value. 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 of amino acid improves the ink adsorption containing the negative charge [4].

This research investigates the effect of nanometer-sized binder of ink jet inks on silk printing, and also compares the size of binders and ratios of pigment-to-binder that affect print quality of silk printing in terms of color gamut, ink penetration in the silk fabrics inter-color bleeding, optical density of inks on fabrics and physical properties such as dry-wet crock fastness, wash fastness, bending stiffness, and air permeability of printed silk fabric.

Silk is organized into group of fibers as a luxurious, beautiful, and individuality. Silk is the strongest natural fiber and is a fine continuous monofilament fiber of high luster and strength but still flexibility that made silk has hard wrinkle. This fabric is wearability because of its high absorbency. Silk may yellow and fade with the use of a high iron setting and weakened by sunlight and perspiration. Furthermore, silk can be easily dyed and printed in many deep colors.

## 1.2 Objectives of the research work

The objectives of this research are as follows:

1.2.1 To investigate the effect of size of binders in ink jet inks via color gamut, inter-color bleeding, and physical properties of printed silk fabrics.

1.2.2 To study the effect of pigment-to-binder ratio for ink jet printing.

1.2.3 To study the properties and stability of the pigmented ink jet inks.

## 1.3 Expected benefit obtainable from the development of this research

1.3.1 Obtained a suitable quantity of nano-sized binder to print silk fabric

1.3.2 Developed formulation of pigmented ink jet inks suitable for silk fabric.

1.3.3 Obtained an improved quality of printed silk fabric.

## 1.4 Scope of the research work

This research focused on the comparison of the nano-sized binders that affect untreated and chitosan treated, printed silk fabric. Pretreated silk fabrics were viewed by Scanning Electron Microscope (SEM). Pigment-to-binder ratios and binder sizes that affect viscosity, pH, surface tension, particle size distribution, zeta potential, ink stability, interaction between pigmented ink jet inks and silk fabric, color gamut of ink jet inks on silk fabrics, optical density of inks on fabrics, inter-color bleeding of ink jet inks on printed silk fabric, inks penetration in the silk fabrics, and physical properties such as dry-wet crock fastness, wash fastness, bending stiffness, and air permeability of printed silk fabric were investigated.

## 1.5 Content of the research work

This thesis consists of 5 chapters as follows: Chapter 1 gives general introduction. Chapter 2 deliberates the principles of ink jet printing process, the ink systems and compositions, properties of ink jet inks, a brief description of chitosan pretreatment, silk fibers and their properties, textile testing and the literature review of related previous works. In Chapter 3, the details about the materials, apparatus and procedure of this research are explained. Chapter 4 presents the results and discussions of the ink jet inks and printing quality of the silk fabric such as dry-wet crock fastness, wash fastness, bending stiffness, and air permeability of printed silk fabric. Moreover, this research studied physical properties of ink jet inks with nano-sized binder on untreated and chitosan treated silk fabrics. Finally, the conclusions and recommendations for the future work are included in Chapter 5.