CHAPTER I
INTRODUCTION

Due to ozone depletion, there has been a progressive increase in the incidence of skin cancers. From Skin Cancer Foundation's 2007 database, skin cancer is the most common form of cancer in the United States. One in 5 Americans and one in 3 Caucasians will develop skin cancer in the course of a lifetime. More than 90 percent of all skin cancers are caused by exposure to UV radiation from the sun.

Among UV protection methods recommended by WHO, such as avoiding prolonged exposure to direct sunlight, wearing sunglasses, and using sunscreen, the use of UV-protective clothing is viewed as a feasible addition. The UV-protective properties of clothing have been known for many years and the factors that affect the amount of protection have been reported previously (Gie *et al.*, 1997; Alvarez and Symonowicz, 2003; Hatch and Osterwalder, 2006). Light bleached, uncolored cotton garments which are very popular in summer do not provide sufficient protection against UV radiation (Davis *et al.*, 1997). The interest in the use of UV absorbers to enhance the UV protection of textiles is growing strongly. In this study a UV absorbing system was attached to an organic monomer structure which was then applied to a cotton fabric via surface polymerization. In the present work two ways to produce UV-protective cotton fabric via surface polymerization, the admicellar polymerization and the use of a silane coupling agent, were studied.

Admicellar polymerization is an *in-situ* polymerization reaction in the core of a surfactant bilayer adsorbed onto the substrate surface to apply a thin polymeric film on the surface. Admicellar polymerization has been successfully used to form various types of polymer thin film on different substrates such as polystyrene on alumina (Matarredona *et al.*, 2003) and cotton (Pongprayoon *et al.*, 2002, 2003), styrene-isoprene copolymer on glass fiber (Barraza *et al.*, 2001), and polypyrole on mica (Yuan *et al.*, 2002). This method is simple with low energy consumption and there is no blocking of the interstices between fibers and yarns, thus good air permeability of the fabric is maintained. Also, since the applied film is very thin, in nano scale, the fabric retains its pliability and soft touch. Thus in this work, a monomer with a benzophenone unit was synthesized and then polymerized on the cotton surface via admicellar polymerization to produce a UV-protective cotton fabric.

Since each such type of the UV blocking species selectively absorbs UV radiation strongly over a certain wavelength range only, more than one type of absorbers are needed to achieve the protection over the whole UV region. It is well-known that copolymerization is an effective approach to obtain materials with tailored properties that are usually improved with respect to those of the homopolymers. Recently, copolymerization has been used in the preparation of electroluminescent polymers with the aim of producing easy tuning of emission colors or adjustable light emission (Cho *et al.*, 1999; Sohn *et al.*, 2002; Peng *et al.*, 2006). The method has also been employed to improve the performance of polymers containing photochromic functional groups, such that the final copolymer will possess photochromophores with uniform distribution (Buchholtz *et al.*, 1993; Liang *et al.*, 2005). Thus, in the present work, copolymerization was utilized to achieve a broader and more uniform UV absorbance over the entire UV region to improve the performance of UV-protective clothing. Benzotriazole and benzophenone, two types of UV absorbers with complementary UV absorption, were incorporated into monomers which were copolymerized onto the cotton fabric via the admicellar polymerization technique. The monomer reactivity ratios in the copolymer system were investigated and the UV-absorbing efficiency of the copolymer was studied based on the analysis of the composition of the comonomers used.

Demands for comfort and healthy lifestyles make it desirable to have textile products with multifunctionality. Moreover, such products can also be the answers for some special applications with enhanced commercial value. Thus, there has been an increase in the study of multifunctional textiles such as water-repellent and antibacterial nylon fabrics (Lin *et al.*, 2002), antimicrobial and blood repellent cotton and nonwoven fabrics (Lee *et al.*, 1999). In this work, a double coating via admicellar polymerization was used to produce a bifunctional cotton fabric possessing both UV-protective and water-repellent properties. Such fabrics will be suitable for outdoor usage where both UV-protection and water repellency are required such as covering materials and protective clothing. For UV-protective properties, a monomer with a UV absorbing unit, 2-hydroxy-4-acryloyloxy-benzophenone (HAB) was used. For water-repellency, a silicon compounds, methacryloxymethyltrimethylsilane (MSi), was chosen as the non-fluorinated monomer to form hydrophobic cotton surface since fluorochemicals have high cost and pose potential risk to humans and the environment. The UV-protection and water-repellency properties of the double-coated fabric were investigated.

For surface modification of a fabric, durability of the coated film is an important factor. In order to obtain an improved adhesion, a new coating method which provides a covalent bonding with the cellulose molecules is needed. A silane coupling agent can be grafted to cellulose with a covalent bonding and it has been widely employed for surface modifications. Silane coupling agents are often used to improve the adhesion between a polymer matrix and reinforcements (Plueddemann, 1982). However, there has been no study on the use of this technique to modify a textile fabric surface. In this work, vinyltriethoxysilane (VTES), which is relatively inexpensive, was grafted to a cotton fabric to provide a vinyl group for further surface modification. The vinyl groups of VTES were allowed to react with an organic monomer containing a UV-absorbing system, 2-[3-(2H-benzotriazol-2-yl)-4-hydroxyphenyl]ethyl methacrylate (BEM), via surface polymerization reaction to form a thin UV-absorbing film coated on the fiber surface.