CHAPTER 1

GENERAL INTRODUCTION

1.1 INTRODUCTION

Microfibres were introduced some 40 years ago, and researchers starting from the late 1990 have attempted to study the various aspects of them. Hwang et al (2001) published a comprehensive paper on carding of microfibres which remains till the current time the only concentrated research publication. The limited range of end use of microdenier yarn has not facilitated continued interest in the understanding of the processing of fibres.

Most of the previously reported work on microdenier fibres was on polyester, and very little published work exists elucidating the various aspects of the processing of other microfibres such as viscose, modal and lyocell or the final yarn and fabric properties. On the investigation of the influence of the processing of microfibres and properties other than polyester, the literature seems to be scanty.

There is also little or no published work relating to their yarn structure and also on the properties of yarns produced by various spinning technologies. Due to the wide differences in physical and mechanical properties of microdenier fibres compared to normal fibres (conventionally used), the understanding of the process currently available is inadequate to optimize and control the process. New spinning technologies such as compact spinning are challenging the existing technology and hence research on yarns
spun on this system is warranted. It is very important to know the difficulties involved in processing these fibers with a view to know the limitations in the application of these fabrics. To obtain a better understanding of the yarns and fabrics relating to microfibres, the various aspects such as carding performance and fibre migration in microdenier yarns were investigated in depth.

To understand the impact of carding variables on the efficiency of carding of microfibres, a Box and Behnken (1960) statistical design was applied to the experimental results. Ramatal (1998) has reported that microfibre fabrics show higher values of bending and shear properties and are slightly harsher than those of regular yarn fabrics.

One of the most significant developments in recent years has been the technology to extrude extremely fine filaments while maintaining all of the strength, uniformity and processing characteristics expected by textile manufacturers and consumers. These microfibres are even finer than luxury natural fibres, such as silk. This comparison, coupled with their exceptional performance, has led some in the industry to refer to microfibres as “supernatural”. Upto now, there is no generally accepted definition for microfibres. But normally the term is linked to the fibre diameter and/or weight/ length of filament in dtex or denier and not with any properties of the fibre. Fibres in the 0.1 to 1.0 dtex range are termed as microfibres and the fibres finer than 0.1 dtex as ultra-microfibres. Any fibre finer than silk can be termed as a microfibre.

The synthetic fiber industry all over the world has seen a tremendous growth and technological development. The development and innovation of various man made fibres has found an end use in different applications for textiles, industrial, medical, geo textiles and even contributing to the space technology. Synthetic fiber, especially the micro fiber
development, has made a big way for sophisticated textiles and apparels, medical and allied applications. Microfibres have found their way into almost any area conceivable as their novel properties offer huge potential in terms of both function and aesthetics. Production of polyester fibre has rapidly increased since its introduction in the world market in the 1950s and presently, polyester accounts for almost 52% of the world synthetic fiber and nearly 25% of the world’s textile fiber production. Continuous research work to improve performance and versatility has led to the development of many new polyester fibres among which is micro fibre polyester.

Nau (1994) reports that since about the mid-1980s, the market importance of manmade fibres of the fourth generation, microfibres, has been rising, including in Western Europe. They open up new marketing opportunities to the fabric manufacturers and inspire the fashion designer to new creations. They were marketed in the form of non-wovens simulating suede, some under the “Alcantara” brand name. Outerwear was produced from them with very great sales success. In recent years, the annual output of synthetic staple fiber alone totals approximately 13 million tons. Cotton output is stagnating at 18 to 20 millions per year due to limitations on areas under cultivation and high water consumption. With an annual output of 11 million tons, polyester is the most important man made fiber. Micro staple fibres have increasingly been gaining importance and the output of all raw materials currently amounts to approximately 600 thousand tons per year.

Amongst the man-made fibres, microfibres are those which can claim to have opened up new and previously unexplored outlets in the apparel sector. They possess novel physiological properties and impart to the textiles produced with them entirely new characteristics such as handle, softness, drape, cover and lustre. In blends with other fibres new unusual cloths can be produced which are of indisputable top quality in appearance and comfort. On the other hand, the use of microfibres enables finer yarns to be
manufactured. Schenek and Schwippl (2005), in a study on processing properties of polyester microfibres in COM4 staple fiber spinning, found that higher yarn strength is possible with good running properties due to a higher number of fibres in the yarn cross section. Microfibres, used alone or in blends, have created considerable interest in the apparel industry because of their potentially greater comfort and functionality. Additionally, their lower diameter, greater surface area and flexibility offer many applications in areas of non-wovens such as filtration, man-made leather, protective clothing and wipes. More recently, fine man-made fibres were developed with the intent to simulate silk. Microfibres less than half size of the finest silk are now available commercially and furthermore microfibres as small as 0.001 dpf are produced by Toray of Japan. US fiber producers have decided not to manufacture microfibres of denier lower than 0.5 due to the difficulties involved in converting finer fibres to yarns as reported by Hwang et al (2001). Hence it was decided to study the mechanical and structural aspects of these microfibres that would be useful to the user industry.

1.2 MICRO FIBER PRODUCTION TECHNOLOGIES

Okamoto et al (1972), a chemist in the Toray industries textile research laboratory, introduced the first microfibre in the mid-sixties. Initially, the microfibre had various limitations, which were overcome by the success of imitation leather. In many product lines, it is the luxurious feel and look of the fabrics that make microfibres so special. In others, it is its unique physical and mechanical performance. Today, the microfibres have taken a place of their own by virtue of their unique properties and end uses.

The microfibres are now manufactured with highly skilled techniques such as conjugate spinning requiring a highly complex spinneret, melt blowing and flash spinning. Ultra-fine fibres are classified into two types: (i) a continuous-filament type and (ii) a random (staple) type. It is
worth a mention that most of the developments in the field of microfibres have happened in the field of direct spinning.

The various methods of manufacturing microfibres are given in Figure 1.1.

1.2.1 Manufacturing Processes for Ultra-fine Fibres

1.2.1.1 Continuous-filament type

Ultra-fine fiber of the continuous-filament type is now produced by a variety of methods as shown in Figure 1.1.

Figure 1.1 Classification of microfibre manufacturing methods


1.3 PREVIOUS RESEARCH DONE

Hwang et al (2001) have carried a systematic investigation on the processing of microfibres in card. Leifield (1992) has studied the carding of microfibres.

Rakshit and Schwippl (2007) have studied the spinning of polyester microfibres in compact spinning. The results show that the yarns produced from microfibres exhibited higher strength and lower hairiness in comparison with the regular yarns. Gong and Mukhopadhyay (1993) made a comparative study on low stress mechanical properties of micro fibre fabrics with silk fabric as a reference and found that microfibre fabrics are soft and smooth but do not have the high kishimi hand which is typical of silk fabrics. Behera et al (1998) have made studies on handle of microdenier polyester filament dress materials and compared the same with fabrics produced from normal denier yarns. The study revealed that sizing was the most important process for microdenier micro filament yarns to realize its speciality effect in the fabric made out of this yarn. Schacher et al (2000) report from a comparative study on thermal insulation and thermal properties of classical and micro fibre polyester fabrics that fabrics made of microfibres show lower heat conductance and therefore have higher thermal insulation properties. Microfibre exhibits warmer feeling than classical polyester fabrics depending on pressure, which may be due to the differences in fibre and fabric contacts with the human skin.

An investigation of low stress mechanical property and handle of fabrics made from micro denier, polyester and lyocell fibres was carried out by Ramatal (1998) and reported.
1.4 OBJECTIVES OF THE PRESENT STUDY

In this thesis, considerable amount of experimental work has been carried out on the effect of carding variables on aspects such as fibre breakage, short fibre content and mean length as the microdenier fibres are likely to break during processing. A novel approach in the design of experiments using MINITAB statistical software, which has been discussed by Mathews (2005), is used in this work.

The work presented in this thesis stems from interest in yarns and fabrics produced from microfibres. Yarns using new spinning technologies were produced for studying their potential.

The objectives of the present study are:

1. To investigate the effect of carding variables on the fibre breakage, hooks and cohesion of card sliver.

2. To investigate fibre migration in ring and rotor spun microfibre yarns.

3. To study the yarn characteristics of compact yarns produced from microdenier yarns vis-a-vis regular yarns.

4. To study the properties of weft knitted fabrics made from microdenier and microdenier- cotton blend yarns.

5. To study the properties of bilayered fabrics produced from microfibre yarns and compare the same with regular fibre yarns.


1.5 ARRANGEMENT OF THE THESIS

This thesis consists of 10 chapters. Chapter 2 contains an extensive literature review on microfibres and their performance. Chapter 3 presents materials and methods used in the study.

Chapter 4 discusses the analysis of the results on the effect of carding variables on the fibre breakage, short fibre content and neps. A Box and Behnken (1960) statistical design was applied to the experimental results to develop a processing window which will produce card sliver with minimum fibre breakage.

Chapter 5 presents a study on yarn characteristics produced from compact and regular spinning using microfibres.

Chapter 6 discusses the structural aspects of microfibre yarns such as fibre migration and yarn packing density produced from ring and rotor spun yarns.

Included in Chapter 7 are the properties of weft-knitted single jersey fabrics produced from micro and normal denier yarns of polyester and viscose, low stress mechanical properties of modal and its blends with cotton.

Chapter 8 deals with the measurement of friction of polyester microfibre knitted fabrics by a novel approach.

In Chapter 9, the properties of bilayered knitted fabrics produced from regular and micro denier yarns are discussed.

Chapter 10 contains the overall discussion and conclusions of the work and recommendations for future work.