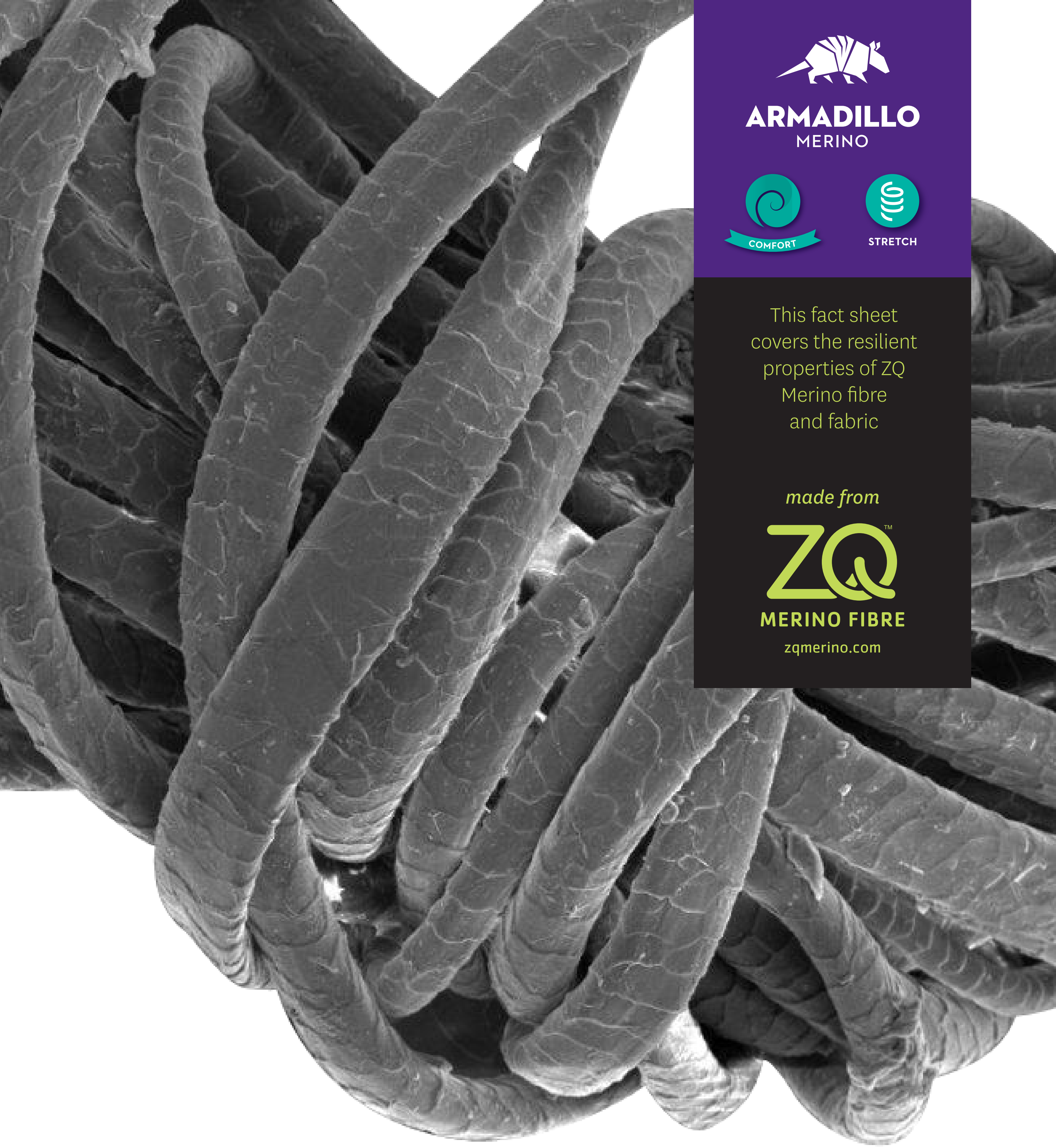

ARMADILLO
MERINO

COMFORT

STRETCH

This fact sheet covers the resilient properties of ZQ Merino fibre and fabric

made from

ZQ™
MERINO FIBRE
zqmerino.com

RESILIENCE

INTRODUCTION

Resilience can be defined as the ability to return or 'spring back' to the original form or position after being bent, compressed or stressed and is used as a measure of the elastic properties of a material. This concept is depicted in Figure 1.

This elastic or stretch behaviour is a key criterion for many materials such as interior textiles, industrial textiles, technical textiles and apparel.

Resilience has a huge influence on apparel comfort and garment performance, as a garment that has elastic properties is easier to put on and remove, and allows for greater ease of movement - particularly across the shoulders, elbows and knees etc where bending and flexing is an important requirement. For technical apparel and apparel for first response applications, a responsive clothing system that is 'fit for purpose' is critical, rather than just being a fashion requirement.

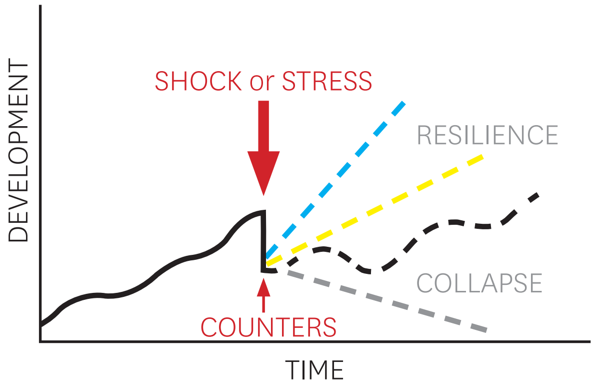

Figure 1, Concept of resilience

WHY RESILIENCE IS IMPORTANT

Resilience can be related to two important performance criteria in a textile system:

- User Comfort
- Extensibility and wear performance

USER COMFORT

Comfort in an apparel system is extremely important for the obvious reasons of both ease of putting on and removal, as well as appearance. However, comfort during wear and use is a key criterion, particularly for active use where repeated stress, bending and extension is required. This is particularly important around significant flexing areas in the body such as knees, elbows and across the shoulders.

EXTENSIBILITY AND RECOVERY

Extensibility and resultant recovery on a repeated basis is very important in the longevity performance of an apparel system and is a key factor in determining how the garment will wear and perform over time. The ability for a garment system to be flexed or extended repeatedly and then to return to its original position or shape is also a governing factor of garment appearance. If a fabric has good extension properties, then comfort is achieved by not constricting the user, but without complimentary recovery properties, the fabric will remain in a stretched or baggy state. This in turn, affects the appearance and resultant performance, rendering the garment not fit for purpose.

PREVIOUS OPTIONS

(LIMITATIONS OF OTHER FIBRES)

There are a number of man-made synthetic fibres on the market that offer a range of very good technical properties such as strength, durability and abrasion resistance in comparison to wool fibre. For example a nylon fibre is stronger than a wool fibre of similar thickness, in that it requires a higher stress to break it whether it is wet or dry, (Figure 2). However, nylon is not capable of stretching as far as wool without breaking, and it breaks at only around 10% of extension. Similarly, polyester fibre also demonstrates much reduced extension properties than wool (Figure 3).

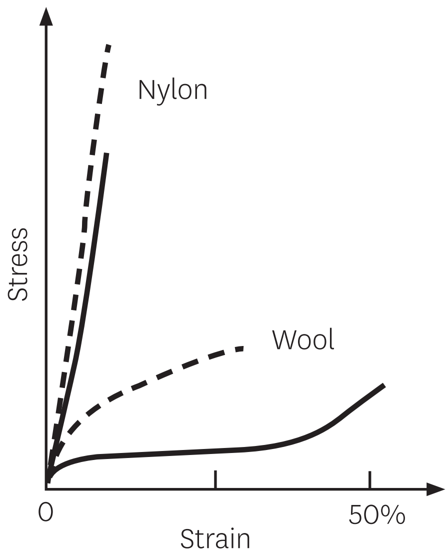

Figure 2. Stress strain curve for wool and nylon, wet fibres are represented by solid lines and dry fibres are represented by dashed lines.

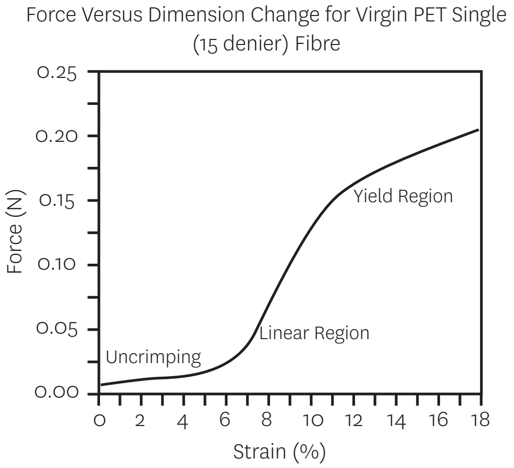

Figure 3. Force versus dimension change for virgin polyester fibre.

There are synthetic polymers that provide very good extension properties and are commonly used in apparel systems to impart stretch comfort. Spandex or elastane is a polyurethane-polyurea copolymer that was invented in 1959 by Dupont which is known for its exceptional elastic properties.

Brand names for spandex include LYCRA (made by INVISTA, previously a part of DuPont), ELASPAN (also INVISTA's), Creora (Hyosung), ROICA and Dorlastan (Asahi Kasei), Linel (Fillattice), and ESPA (Toyobo). This product revolutionised the apparel industry when first introduced as it provided a new level of wearer comfort. It is commonly used in firm fitting apparel such as swimwear, lingerie, skinny jeans, leggings and cycle apparel etc.

Spandex is a generic term used to designate elastomeric fibres that have an extension at break greater than 200% and which show rapid recovery when tension is released. These fibres can exhibit rubber-like behaviour with high reversible extension properties as high as 400-800% (Senthikumar et al, 2011). While these fibres do have exceptional elastic properties, they are hydrophobic, and as such are difficult to dye and therefore cannot contribute to garment breathability and moisture management.

MERINO WOOL SOLUTION

Merino wool has good stretch and extensibility properties which can be related to the internal spring-like structure of wool. In proteins such as wool, about 20 different amino acids are combined, giving an enormous amount of variation in the order in which they are placed to form the protein chain. The protein is composed of a backbone of amino acids linked together and around this backbone are side chains of amino acids. The backbone is twisted into a helical path called an alpha helix (Figure 4) which is the basic structure of wool.

The ability of wool to stretch can be related to this spring-like behaviour of the alpha helix (Figure 3). The hydrogen bonds which link consecutive turns of the helix are broken under tension, thus enabling the coils to stretch more readily. The natural resilience of wool, which enables the fibres to readily return to their original shape, mostly arises from the strong, covalent disulphide bonds (-S-S-) that link adjacent helices. These give some rigidity to the structure and help it to resist stretching.

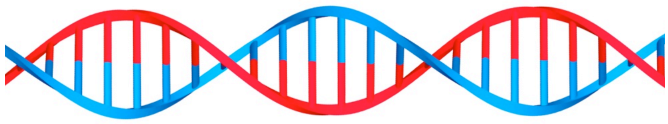

Figure 4. Alpha helix

This translates into an important physical property of the wool fibre in its ability to be extended by more than 30% of its length without breaking and in turn, can recover from extensions of approximately 20% (Wood 2009).

The hydrogen bonds of the wool fibre are most effective when the fibre is dry, and they contribute stiffness to the fibre. When the wool fibre contains moisture, the water molecules reduce the effectiveness of the hydrogen bonds, and the fibre is more readily extended as is demonstrated in Figure 5.

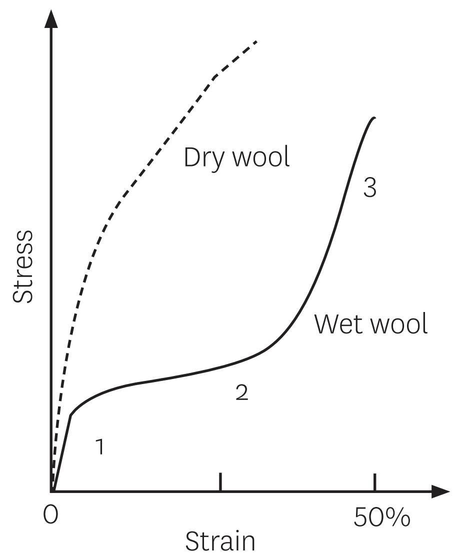

Figure 5. The stress strain curves of wet wool (solid line) and dry wool (dashed line)

Wool fibre also has a natural crimp (Figure 6) which contributes to its resilience performance. This wavelike pattern is due to its extremely complex internal structure. This structure serves to create air spaces, and as such provides a very soft and 'springy' handle. This is an intrinsic property of wool fibre, particularly finer Merino fibre, compared to synthetic fibres which have to be specially manufactured to impart an artificial crimp.

Figure 6. Crimp structure in wool fibres

SUMMARY

Merino wool has good stretch and extensibility properties which can be related to the internal spring-like structure known as the alpha helix.

Wool fibre has very good extensibility properties and can be extended by more than 30% of its length without breaking and in turn, can recover from extensions of approximately 20%.

Wool has superior extension properties compared to nylon and polyester.

Merino wool has an intrinsic wavelike structure called crimp which contributes to its resilience properties

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