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The Effect of Structure and Percentage on Compression Properties of Three-dimensional Knitted Fabrics ⋆

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Abstract

Seamless knitting technology involves knitting diverse tissue structures in the same three-dimensional knitted fabric in horizontal and vertical rows without forming seams, and the transition tissues are typically used for fabric tissues with significant differences in properties, however, it is usually easy to be overlooked in research. Three types of three-dimensional knitted fabrics were transformed in terms of tissue structure and increasing percentage. An AMI airbag contact pressure measurement system was used to establish pressure models with three different diameters of gum cotton cylinders to measure the interfacial pressure of the fabrics to study the effect of transitional tissue on the compression performance of three-dimensional knitted fabrics under tensile load. The study found that when the fabric stretch rate was at 0%, 25%, 50%, and 75%, the fabric stretch rate and pressure were positively correlated; the fabric tissue composition and number of components had a significant effect on the pressure, and the increase in the number of components caused the pressure at the tissue junction to increase significantly. This study aims to lay the groundwork for winter knitted sportswear pattern development and compression performance optimization.

Keywords: Fabric Structure; Tissue Percentage; Interfacial Pressure; Compression Properties

1 Introduction

Seamless knitted garments are made by knitting circular knitting machine technology straight from yarn materials into three-dimensional tubular textiles, then cut and finished without side

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seams and with a particular compression to the human body [1]. Because of their outstanding tensile and elastic recovery capabilities, as well as their soft texture, these garments are widely employed in the production of underwear, tight sportswear, and body-shaping garments [2].

Among them, weft knitted three-dimensional fabrics knit on circular knitting machines, has the ability to knit various tissue structures in both horizontal and vertical rows of the same piece of fabric in addition to having the good tensile recovery of traditional knitted fabrics. Currently, the majority of weft knitted knitted fabric research is concentrated on the knitting technique [3-4], fabric development [5-7], and evaluation of the wearing characteristics [8]. With the widespread use of circular machine technology in the field of compression garments, it has become particularly important to optimize the compression comfort and accuracy of winter sports compression garments. Winter sports compression garments are well-made, elastic compression garments that wrap around the body, are lightweight and physically unrestricted, and are being used more and more widely in sports scenarios. Since the overall sensory changes of garments are influenced by the local sensory conditions of the human body [9-11], it is important to study the regional pressure distribution of garments and the relationship between fabric properties and pressure. Several scholars have argued related to whether compression is beneficial in improving athletic performance: it is thought to contribute to the performance of certain specific speed power activities due to the gaining effect of compression garments on venous blood flow [12] and arterial blood flow [13] by improving blood circulation [14], alleviating exercise fatigue [15] and enhancing exercise efficiency [16-18], thus improving skin sensation [10] by improving the sensory feedback of the body while wearing the garment.

Sports compression garments, for example, exert pressure on the human body through intermittent compression, and the level of that pressure is governed by a complicated interplay of several primary components [19]. Domestic and international scholars frequently employ the cylindrical model as a pressure prediction model to simplify the investigation of the link between fabric qualities and pressure [20-21]. Some scholars have used multiple regression analysis to clarify the compression effect of bandages and stockings to elucidate the factors affecting the compression of clothing [22-23]. In addition, the researchers used finite element method simulations to simulate women wearing a typical compression sports bra to study the pressure comfort during wear [24]. To determine the factors and degree of pressure influencing the contact between weft knitted three-dimensional knitted fabrics used in winter sports compression garments and the skin, three common fabric tissues in winter knitted sports compression garments were chosen. In addition, three different diameters of gum cotton cylinders were modeled to simulate the effect of tissue structure changes and proportion on inter facial pressure, to make up for the lack of existing standardized models. This paper provides some theoretical support for the development and optimization of mechanical properties of seamless knitted ski underwear for circular knitting machines and provides some reference for knitting engineers and manufacturers.

2 Test Model Establishment

2.1 Weft Knitting Three-dimensional Knitted Fabric Design

Under normal exercise conditions, there are significant differences in the level of heat dissipation, sweating, and skin stretch deformation in various parts of the body. A seamless knitted compression garment with excellent performance is usually composed of tissues with certain differences in