Journal of Fiber Bioengineering and Informatics 8:2 (2015) 267–276
doi:10.3993/jfbim00096

Effect of Structural Parameters on Compression Performance of Warp-knitted Spacer Fabric ⋆

Ming Li [a], Huijian Yang [a], Pengfei Liu [a], Zhaoqun Du [a,b,*]

[a] *Key Laboratory of Textile Science & Technology, Ministry of Education, College of Textiles Donghua University, Shanghai 201620, China*

[b] *Engineering Research Center of Industrial Textiles, Ministry of Education, Donghua University Shanghai 201620, China*

Abstract

The main content dealt with in the paper is to analyze effects of structural parameters on compression property of spacer fabrics. Based on compression stress and strain curves, four characteristic indices are featured, which include compression work, recovery ratio of compression work, maximum compression force when compression strain is 0.7 and secant modulus by fitting compression stress – strain curve from strain 0 to 0.25. Experimental results show that structural parameters of spacer fabric, including thickness of spacer fabric and diameter, angle, arrangement shape and density of spacer filament, significantly influence compression behaviour. With the thickness of specimen increasing, compression work increased, while the compression secant modulus and maximum force decreased, and the recovery existed nonlinear relationship and showed a relatively optimal thickness. Compression work, recovery ratio, maximum force and secant modulus existed the same ascending trend when the diameter of spacer filament increased from, while they showed descending trend when spacer angles decreased. The whole structure of spacer fabric was more stable when the arrangement of spacer filament is X-shaped than V-shaped, and the compression work, recovery ratio, maximum force and secant modulus of sample X shape were all larger than those of sample V shape. As for the density of spacer filaments, the compression work, maximum force and secant modulus increased with density decreased, while the recovery ratio of spacer fabric with higher density was smaller than that of smaller density.

Keywords: Warp-knitted Spacer Fabric; Compression Property; Structural Parameters; Thickness; Spacer Filament

1 Introduction

Spacer fabric is a typical kind of the sandwich structure consisting of two separate knitted fabrics that is the upper and bottom layers and flexible filaments that is the inner layer, which forms

⋆This work is supported by National Natural Science Foundation of China (No. 51203022, 11272086), the Fundamental Research Funds for the Central Universities (No. 2232014A3-02) and the "DHU Distinguished Young Professor Program (No. B201307)".

*Corresponding author.
Email address: duzq@dhu.edu.cn (Zhaoqun Du).

many channels to transport heat and moisture in microenvironment between body and clothes, and endows spacer fabric products with good air permeability, moisture permeability, shock resistance, pressure relief, filterability and sound insulation [1–4]. Wherein, compression properties mainly determine on the applications of spacer fabrics to meet special requirement, such as automotive, bra cups, flexible cushioning and padding materials [5–7]. Currently, one researching on spacer fabrics is to have a comprehensive analysis on sound absorption [8], thermal and moisture transport [9], which are used to prove the excellence of spacer fabrics replacing with foam and plastics, such as the wide applications in functional bra support and car seats. The other research is mainly focused on theoretical analyses of a spacer fabric model to predict the spherical ball compression properties by plate compression properties [10–12], which had a sound consideration to establish relations between structure and property of spacer fabrics. However, there are few studies on experimental investigations of structural parameters on compression property of spacer fabrics.

Therefore, the paper mainly aims to feature structural parameters, including thickness of spacer fabric and diameter, angle, arrangement shape and density of spacer filament, to analyze compression property of spacer fabrics. It will be helpful that studying compression behavior of warp-knitted spacer fabrics by designing different structures for producing excellent spacer fabric with proper compression property suitable for mattress materials.

2 Experimental

2.1 Sample Preparation

Ten kinds of warp-knitted spacer fabrics selected were cut into a circle specimen with diameter 10 cm. In order to reduce the errors of sample preparation, specimens were firstly cut into a circle with diameter 10.5 cm, and the spacer filaments were removed away along the circular edge until the diameter was 10 cm. These spacer fabrics were designed by changing spacer filament structures, including angle, arrangement, diameter and density, to analyze their effect on compression behavior. These samples were balanced in standard condition (20±3°, 65±5%RH) more than 24 hours, and all experiments were conducted in the above standard condition. The specifications of samples are listed in Table 1.

2.2 Compression Tests

Compression tester JA12002 is chosen to conduct plane plate compression, as shown in Fig. 1, where motor fixed in main frame drives screw to rotate; then, the upper plane plate connected with a force sensor moved down to compress spacer fabrics pasted on the surface of the bottom plane plate. The pair of plane plates is a circular shape with the diameter being 20 cm and the moving speed being 12 mm/min. When spacer fabrics are compressed, double-side adhesive tapes are used to stick spacer fabric on the surface of the bottom plate in order to avoid slippage phenomenon of spacer fabric on the surface of the bottom plane plate. In order to have a comparison, spacer fabrics are compressed to set one cycle with the compression strain being 70%.