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Development of Stretchable Woven Fabrics with Auxetic Behaviour

Authors : Adeel Zulifqar, Hong Hu

Abstract : Auxetic fabrics are a special kind of textile materials which possess negative Poisson's ratio. Opposite to most of the conventional fabrics, auxetic fabrics get bigger in the transversal direction when stretched or get smaller when compressed. Auxetic fabrics are superior to conventional fabrics because of their counterintuitive properties, such as enhanced porosity under the extension, excellent formability to a curved surface and high energy absorption ability. Up till today, auxetic fabrics have been produced based on two approaches. The first approach involves using auxetic fibre or yarn and weaving technology to fabricate auxetic fabrics. The other method to fabricate the auxetic fabrics is by using non-auxetic yarns. This method has gained extraordinary curiosity of researcher in recent years. This method is based on realizing auxetic geometries into the fabric structure. In the woven fabric structure auxetic geometries can be realized by creating a differential shrinkage phenomenon into the fabric structural unit cell. This phenomenon can be created by using loose and tight weave combinations within the unit cell of interlacement pattern along with elastic and non-elastic yarns. Upon relaxation, the unit cell of interlacement pattern acquires a non-uniform shrinkage profile due to different shrinkage properties of loose and tight weaves in designed pattern, and the auxetic geometry is realized. The development of uni-stretch auxetic woven fabrics and bi-stretch auxetic woven fabrics by using this method has already been reported. This study reports the development of another kind of bi-stretch auxetic woven fabric. The fabric is first designed by transforming the auxetic geometry into interlacement pattern and then fabricated, using the available conventional weaving technology and non-auxetic elastic and non-elastic yarns. The tensile tests confirmed that the developed bi-stretch auxetic woven fabrics exhibit negative Poisson's ratio over a wide range of tensile strain. Therefore, it can be concluded that the auxetic geometry can be realized into the woven fabric structure by creating the phenomenon of differential shrinkage and bi-stretch woven fabrics made of non-auxetic yarns having auxetic behavior and stretchability are possible can be obtained. Acknowledgement: This work was supported by the Research Grants Council of Hong Kong Special Administrative Region Government (grant number 15205514).
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