Multilayer Spacer Fabrics with Through-The-Thickness Auxetic Behaviour

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Abstract

Through-the-thickness properties are important for spacer fabric applications, such as impact protection and cushioning, because the three-dimensional structure of spacer fabrics absorbs energy and resists compression from forces directed perpendicular to the plane of the fabric. Although auxetic behaviour helps to absorb impact energy via material densification at the point of impact, there are limited examples of spacer fabrics with through-the-thickness auxetic behaviour due to challenges in using conventional knitting technology to fabricate complex geometries in the through-the-thickness direction. This study develops flat-bed weft knitted multilayer spacer fabrics with through-the-thickness auxetic behaviour. The approach is to use fabric layers, including spacer fabric layers, to create auxetic geometry in the through-the-thickness direction. This exploits the programmable out-of-plane curling behaviour of knitted fabrics and the flexibility of flat weft knitting to transfer stitches between needle beds to create re-entrant hexagonal cells formed by multiple fabric layers. The spacer fabrics demonstrate negative Poisson's ratios in the through-the-thickness direction, expanding the potential of weft-knitted spacer fabrics for impact protection applications.

Keywords: spacer fabric, auxetic, multilayer, knitting, weft knitting, impact protection, through the thickness

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