Design and Development of woven auxetic textiles and their characterization

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Abstract

Auxetic textiles are intriguing materials with unusual capabilities. These materials exhibit a negative Poisson's ratio, i.e., they expand in the transverse direction when stretched in the longitudinal direction. These materials offer extraordinary performance in fracture toughness, shear resistance, and shock absorbency and exhibit synclastic curvature, mainly due to their special structure and associated deformation mechanics. This exceptional behavior of auxetic textiles can be obtained by a fundamental understanding of auxetic geometry, followed by developing, analyzing, and translating it into appropriate textile structures for actual fabric production. Also, the characterization of auxetic fabrics and their composites is very crucial. This auxetic behavior in woven fabrics can be achieved by utilizing auxetic yarn, warp and weft of different extensibility, and combining loose and tight weaves. Also, the selection of matrix material for the development of composites should be such that it allows the fabric auxeticity to be retained in the composite stage. These auxetic woven fabrics and composites can potentially revolutionize their applications in and as geotextiles for storm and flood mitigation, soil reinforcement, military applications in bulletproof vests, blast-proof curtains, and protective wear such as knee, elbow, and shoulder pads, in and as functional clothing for maternity and children wear. Also, some of the properties of auxetic materials make them suitable for biomedical engineering, where these can be used to develop stents, prosthetics, special wound care bandages, etc. In contrast, composites can be used for blast-resistant vehicles, shoe midsoles, helmet shells, and automobile crash boxes.

Keywords

Auxetics, Energy absorption, Auxetic textiles, Negative Poisson's Ratio