Thermal and Mechanical Characterization of UHMWPE based Knitted Textiles for Cut-Protective Applications

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This study emphasizes the critical need for effective cut-resistant fabrics in various industries and everyday activities to prevent injuries. The conventional tomodynamometer, commonly used for cut resistance testing, is limited to room temperature evaluations and does not account for real-world conditions such as temperature variations, rubbing, and stretching. To address this, the paper proposes a modified tomodynamometer that integrates a contact heat source, radiant heat source, abrasion, and stretching functionalities. This modification aims to provide more accurate cut resistance test results under diverse thermal and mechanical conditions, enhancing the development of reliable protective clothing. The study focuses on the development and analysis of high-performance yarn-based cut-resistant knitted fabrics. Three types of fabrics were created using 100% ultra-high molecular weight polyethylene (UHMWPE), steel-reinforced UHMWPE, and glass-reinforced UHMWPE yarns on different knitting machines. The impact of core reinforcements, such as stainless steel and glass fiber, as well as knitting variables like stitch density and machine gauge, on cut performance were investigated using a tomodynamometer. The findings reveal that the 13-gauge shimaseiki gloves knitting machine, producing steel-reinforced UHMWPE fabric with a stitch density of 150 loops/inch^2, exhibited the highest cut resistance. Scanning electron microscopy images illustrated the structural contribution of core-reinforced yarns to the cut performance of knitted fabrics. Overall, the study's results provide valuable insights for developing superior cut-resistant fabrics to enhance worker safety in various industries.