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The influence of carbon nanotubes on quasi-static puncture resistance and yarn pull-out behavior of shear-thickening fluids (STFs) impregnated woven fabrics

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Abstract

This study focuses on the puncture resistance performance of woven high modulus polypropylene (HMPP) fabric impregnated with shear-thickening fluids (STFs) composed of fumed silica nanoparticles suspended in polyethylene glycol (PEG) and those containing carbon nanotubes (CNTs). The shear-thickening characteristics and rheological features of suspensions were determined at steady and oscillatory shear stress using a stress controlled rheometer. The puncture resistance performance of STF-treated HMPP fabrics were evaluated by the quasi-static puncture test. To gain a better understanding of the effect of these two suspensions on puncture resistance mechanism of fabric, yarn pull-out test was conducted to examine internal shear strength and inter yarn frictional behavior of fabric. The results showed that both the STF-treated fabrics exhibited significant enhancement in puncture resistance performance as compared to neat fabric. However, the fabric impregnated with the suspension containing CNTs showed lower enhancement, due to its lower degree of shear-thickening as confirmed by rheological measurement. The possible improving mechanisms responsible for puncture resistance performance of STF-treated fabrics were also discussed.

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