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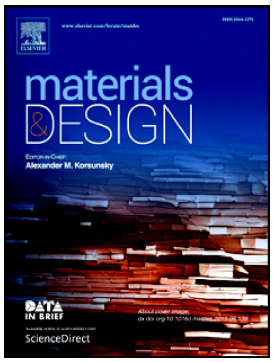

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Development of Flexible Particle-laden Elastomeric Textiles with Improved Penetration Resistance to Hypodermic Needles

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Abstract

Needle stick injuries are a major concern for workers in hospitals, service and hospitality sectors. Current prevention strategies include double/triple gloving reduce flexibility significantly and also do not provide a significant reduction in injuries as desired. Here, we develop a new particle-laden elastomer using colloidal silica (CS) and polydimethylsiloxane (PDMS) which when coated onto high-density polyethylene (HDPE) woven fabric shows a remarkable 90% increase in specific penetration resistance force (SPRF) to hypodermic needles as compared to the neat fabric. We show that the resistance to penetration is dependent on the concentration of the hard silica particles and hypothesize that a percolation network of connected particles form upon impact that distributes the load and provides high resistance. We term this phenomenon as elastic jamming. Furthermore, we also show that by adding silicon carbide nanoparticles to CS increases the SPRF to 110% of neat fabric. A two-layer stack of the same treated fabric was able to completely prevent the penetration of a 21 G needle at a speed of 50 cm/min in about one-third of the performed experiments. These results demonstrate that impregnation of textiles with these nanocomposites can be an attractive method for the manufacture of needle stick penetration resistant garments.