BALLISTIC PERFORMANCE OF SOFT BODY ARMOUR: EFFECT OF PARTICLE SIZE OF SILICA IN SHEAR THICKENING FLUID AND STACKING SEQUENCE OF FABRICS

Bajya M., Majumdar A., Butola B.S.
Department of Textile Technology, Indian, Institute of Technology Delhi, New Delhi, India
ttz178350@textile.iitd.ac.in

ABSTRACT

Shear thickening fluid (STF) has been used by the researchers, in the past few years, in order to improve the ballistic performance of bullet resistant and stab resistant personal protective soft armour. It has been reported that the STF treated soft body armour panels, evaluated against low-velocity projectiles, shows the improvement in the impact performance.

This study investigates the effect of size of dispersed phase i.e., silica particle on the performance of soft body armour panels when explored against the high-velocity bullets. STFs were prepared using silica (SiO_2) particles of 100 nm and 500 nm and dispersing them in polyethylene glycol (PEG-200). Kevlar 363 2S fabrics, having areal density of 200 g/m2, were impregnated with both the STFs using a padding mangle. Multiple layers (20-24) of fabrics were stitched to prepare 13 soft armour panels. Ballistic studies were evaluated in terms of BFS (back face signature) against 9×19 mm lead core bullet having a velocity of 430±15 m/s and five bullet shots were fired on each panel (250×250 mm2). There were two sets of soft armour panel configuration for each type of STF, one set having fixed overall areal density for neat and STF treated panels and the other set having a fixed number of fabric layers for neat and STF treated but with varying positions (at striking face or away from striking face) of STF treated fabric layers.

This study revealed that both STF treated panels gave lower BFS, lower weight of panels and less number of layers. For 100 and 500 nm particle size, STF treated soft armour panels gave 15.8% and 20.2% lower BFS, respectively, compared to that of neat panels having same number (24) of fabric layers. However, the reduction in areal density and BFS, with respect to neat armour panel having 24 layers of fabric, was 10% and 5.1%, respectively, for 100 nm particle size; and 6 % and 11.2 % for 500 nm particle size. Therefore, higher size (500 nm) of silica particle in STF helps to reduce the BFS due to more prominent shear thickening behaviour. Besides, STF treated fabrics should be placed away from the striking face so that the fluid gets enough time to respond to ballistic impact which ultimately reduces the BFS.