Upon Impact: The Effects of Shear-Thickening Fluid Impregnation Into Kevlar on High Speed Impact

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Shear-thickening fluid (STF) impregnation into aramid-fiber materials is a new concept with most of its advancements happening within the past ten years. This project tested two samples, a 100:5:1 and a 100:1:1 compound of polyethylene glycol, fumed silica (SiO_2), and zirconium dioxide (ZrO_2), as well as two controls, a dry control of untreated aramid-fiber and a carrier control of aramid-fiber impregnated with only polyethylene glycol. The 1:1 solution was hypothesized to break up the projectile the most, although the 5:1 solution was determined to be the most effective. To test this, the samples were shot with a 3mm aluminum projectile at 3 km/s using a two-stage light gas gun. Maximum exit hole diameter, penetration into ballistic gel placed behind samples, and mass gain were analyzed to determine if the sample was effective. Exit diameter must be equal to or less than 4mm to pass NASA (National Aeronautics and Space Administration) standards. The dry control, carrier control, and 1:1 samples were deemed ineffective because of exit diameter and other outcomes were not judged for pass/fail. The 5:1 sample stopped the projectile entirely and had no exit hole; it passed all criteria and was deemed effective. This technology can be implemented into the outer protective layer of extravehicular spacesuits to make them both more efficient and more flexible.

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