Solving the Hip Fracture Crisis: Utilizing Silica Nanoparticles to Synthesize a Flexible, Affordable, and Bio-Friendly Shear Thickening Fluid Based Innovation

Jain, Avni

My research aims at utilizing recent advances in the molecular engineering of shock absorbing materials, to develop a flexible, affordable, and bio-friendly hip guard, providing an armor-like protection against hip bone fractures. Shear thickening fluids (STF) were prepared by uniformly dispersing MP-2040 Colloidal silica (40%) in Acrysol RM-7 Rheology Modifier (60%). The nanoparticles were suspended by slowly mixing for 24 and 48 hours in a magnetic stirrer. Jute, a bio-friendly, plant derived fabric was impregnated in STF. Seven multi-layered prototypes were developed. An average force at impact of 10040.55 pounds or pressure at impact of 78.44 kg/cm2 was successfully simulated in the ball drop impact test. A spherical ball with a uniformly distributed mass of 0.25lb was used to conduct measurements at 3 different heights. A set of 15 repeated trials were taken for each prototype adding up to total of 315 tests. The results of the tests exhibited that the STF treated fabric offers superior protection compared to the untreated fabric. STF solutions stirred for 24 and 48 hour provided impact reduction of 42.85% and 90.51% respectively against the control. The prototype, impregnated with the 48 hour stirred STF solution, provided additional 47.76% reduction, suggesting that silicon nanoparticles were more uniformly suspended when stirred for longer duration. No incremental benefit was noticed with 3-layer patch, indicating that force at impact reduction was maximized with 2-layer patch. This research opens up promising possibility for economically viable and flexible guards for hip bone protection and further extension into other protective applications.