Designing High-Performing, Low-Cost Shock Absorbing Composites for Injury Protection by Impregnating Woven Fabrics with Shear Thickening Fluids

Saha, Aaditya (School: Chamblee Charter High School)

Millions of sports and recreation-related injuries occur each year. Shock absorbing composites using shear thickening fluids (STF) or dilatant materials were fabricated and tested with the goal of exploring their potential as protective sportswear. The role of geometric patterns in woven fabrics and laminates, their strengths and stiffnesses, compositions, particle to carrier fluid ratios in STF mixes and the interplay among these factors in mitigating impact shock were studied. Drop tests were conducted by releasing a 6.26 lb weight from an electromagnet on fabricated STF composites, with contact pressure measurement films placed underneath them, to measure the impact pressure. Results were statistically analyzed and related to possible mechanisms in the STF and its interface with the fabric during impact. The weight and height of drop were chosen based on typical forces on impact that cause injury in sports. A composite of nylon fabric and silica-polyethylene glycol STF mix in 4:1 ratio displayed better shock absorption behavior than other fabricated composites with Kevlar or carbon fiber with silica or kaolinite STF mixes and equaled commercial shock absorption materials such as D30 or Poron, despite being thinner and more flexible. Geometric configurations of composites, the ratio of particle-carrier fluid in STF mixes, and climatic conditions were also determined to play a role in shock absorption performance of these fabricated composites. The study successfully demonstrates that STFs can be used to fabricate high-performing, low-cost protective composites for sportswear. It also unlocks the potential of flexible woven textile fabrics for new shock absorption applications.

Awards Won: