3D Printed Foam Structures for Safer High School Football Helmets

Nathan, Varun (School: James Madison Memorial High School)

Football is one of the most popular American sports, and some of the most exciting beginnings of this sport are in high school. Concussions are unfortunately a prominent consequence of the sport, and its effects are even more dangerous in high school athletes. Unlike in higher leagues of the sports, the head protection leaves much to be desired. In this project a new syntactic foam material based helmet liner is printed into impact absorbing lattice structures to greatly reduce the risk involved in head-on collisions and sheer impacts. A light weight, recyclable, thermoplastic polyurethane was blended with glass microbubbles to create a composite material by laser sintering. The material composition was optimized to maximize the tensile strength and modulus. Four lattice structures were printed using laser sintering using computer aided design (CAD) software and compression tested. The syntactic foam with 40 weight percent filler maximized the tensile modulus of the material. The Diamond and Gyroid structures were found to be ideal for their non-directional structure, providing high impact absorption. The conical lattice structure exhibits the desired multiple steps of deformations to absorb impact, however due to their low structural density, they lacked the high modulus needed for a liner. A scaled model of a gyroid lattice based liner was printed as proof of concept, of an effective lightweight, 3D printed, recyclable, high impact absorbing prototype.

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