Optimizing Composite 3D Printed Running Shoe Plates as a Replacement to Expensive Carbon Fiber Standards

Pingry, Isaac (School: Academies of Loudoun)

How efficiently a runner uses their energy at a submaximal pace is called an individual's running economy. Current running shoes incorporate a plate made from carbon fiber which results in an improved running economy. Plated running shoes have a high manufacturing cost with pairs ranging in price between $200 and $300. Development of a customizable 3D printable plate would lower manufacturing costs, allowing for an introductory shoe providing a more affordable option for new runners. Customized plates were prototyped based off of a Brooks Ghost midsole design and 3D modeled in CAD software. Three types of carbon-fiber filaments with additives were then tested: carbon-fiber and thermoplastic polyurethane (CF+TPU), carbon-fiber and nylon (CF+PA6), and carbon-fiber and polycarbonate (CF+PC). Mechanical tests were conducted to determine which material had the optimal structural performance through force displacement graphs. A biomechanical VO2 test was completed to determine the oxygen intake, to verify the improvement of running economy. VO2 test data was collected with and without CF+PA6 plates. The data was then cleaned so that the plates could be compared to current industry carbon-fiber plates. The CF+PA6 plates had the most energy return during the mechanical testing phase, proving that the plates increased the energy return of the modified shoe. The subsequent VO2 test proved that the running economy was also improved showing lower oxygen intake and overall efficiency. These data points suggest that these low cost plates have the potential to significantly lower manufacturing costs compared to current industry production.

Awards Won: