A PEEK into the Future: Advanced Materials for Orthopedic Implants

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This study's engineering goal was, "design and test 3-D printed PEEK (PolyEtherEtherKetone) for durability for possible use in less-invasive orthopedic knee implants." This project had two phases. For phase one, a CAD 3-D model of a knee, based on an MRI scan, was used to design the experimental pieces. The models were sent to a 3-D printing company to get 3-D printed using PEEK. They were mounted on circular aluminum substrates. Phase two tested PEEK's durability. A modified version of last year's test rig was used, with a main piston sliding the top and bottom pieces over one-another, and a second piston applying force to simulate body weight. A key addition to the system was immersion of the models in a saline-solution basin to simulate synovial fluid in the knee. The project used three indicators to measure wear: weight, thickness, and surface smoothness. Measurements were taken at regular intervals. The models survived testing for 359 hours, or 1,507,800 cycles, at which point the test rig failed despite continual repair. The top model lost 1.32 grams (initial 374.79), and the bottom lost 1.77 (Initial 256.58). For thickness, the top lost .006 inches, and the bottom lost .007 inches. Both models smoothed out, with correlated decrease in wear, as testing continued. In conclusion, the 3-D printed PEEK models demonstrated viability in terms of indicators tested for possible use in less invasive knee replacements. Future research may include testing the integration of surface treatment that may allow bone tissue growth into the implant.

Awards Won:
Third Award of $1,000