The University of Mississippi Medical Center
Hip Wear Simulation Laboratory

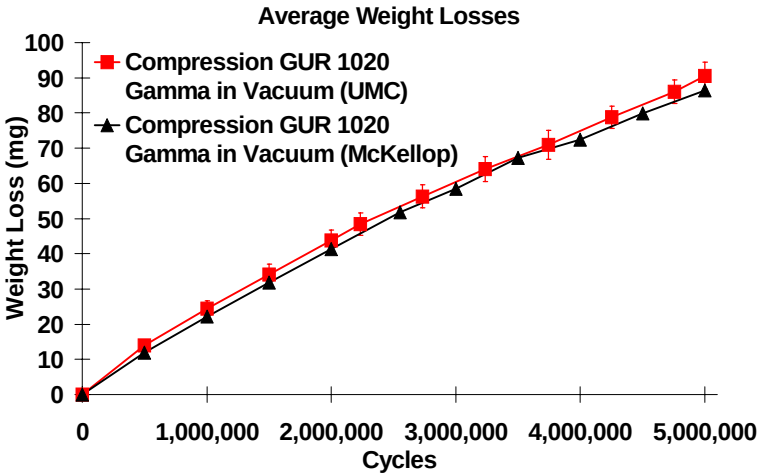
Facilities

The laboratory contains an MTS Eight-Station Hip Wear Simulator custom-designed with an extended crosshead height allowing taller-than-usual samples to be fixtured in the machine. Each station is equipped with a 2000 lb (10 kN) load cell, a 20 N-m torque cell, and a ± 50 mm LVDT for displacement measurement. Control is provided using MTS TestStar II hardware and software giving three channels of control and 27 channels of data collection. The hydraulic cylinders are split into two banks so that load can be applied to four stations independent of the other four stations. Additionally, the hydraulic line to each cylinder is individually valved so that any one or more stations may be turned off during operation. All actuators rotate in unison at rates controllable from 0 to 120 revolutions per minute.

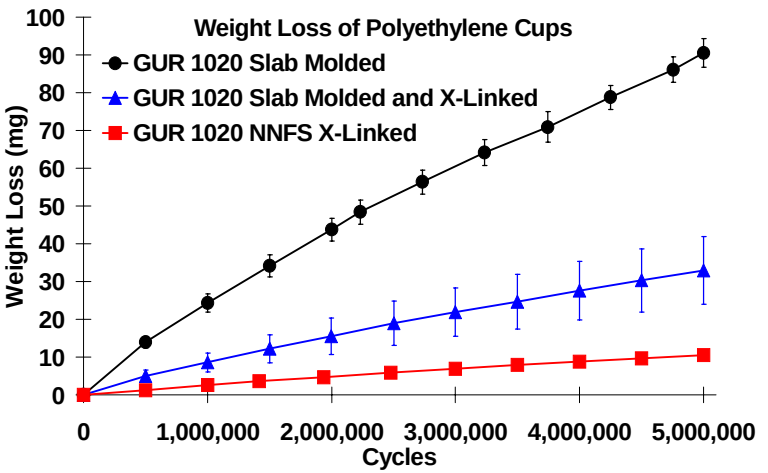
Photo of MTS Eight-Station Hip Wear Simulator

Representative Experimental Results

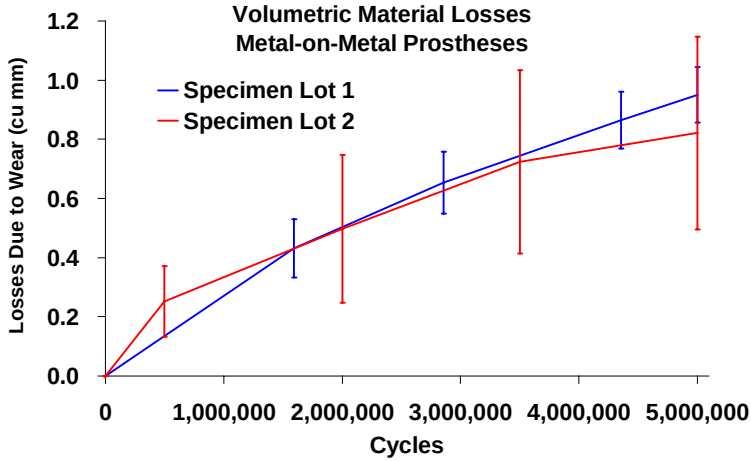
Experiment 1: Polyethylene acetabular cups (28 mm) which had been manufactured from slab-compression–molded GUR 1020 UHMWPE resin (Perplas, Inc.) and packaged and (-sterilized under vacuum were tested in the anatomic position with 3000N Paul curve loading to 5,000,000 cycle and the results compared to the results of McKellop[1] for nearly identical material that was tested in the head-down configuration on a Shore-Western simulator:



Experiment 2: Cross-linked GUR 1020 acetabular cups which had been slab-compression-molded and then machined were compared (in the anatomic position) to cups which had been near-net-final-shape compression molded and compared to cups which had not been cross-linked:[2]



Experiment 3: Metal-on-Metal hip prosthesis components were manufactured from Co/Cr alloy which was in compliance with ASTM F1537, high carbon content. The 28 mm head and cups sets were tested in two separate sets of five samples to five million cycles. Weight loss, torque, metal ion content of the serum, and temperature of the serum were measured and recorded:[3,4]



Other Capabilities

As a result of the increased head space in the hip simulator and the presence of individual LVDTs and load cells on each station, multi-station hip fatigue or other fatigue studies can also be performed on this equipment.

In addition to the simulator, the laboratory also has a custom-built five station pin-on-disk (POD) wear tester[5] which allows for reciprocating POD material screening for applications involving wear. The stroke distance is 1 cm and the load can be varied by the application of weights.

The laboratory is a part of the Biomaterials Group within the Departments of Orthopaedic Surgery and Restorative Dentistry and, as such has access to comprehensive instrumentation for metals, polymer, and ceramic characterization, histological preparation and analysis, mechanical testing, and light and electron microscopy. A complete list of capabilities and instrumentation is available.

References

1. McKellop HA, Shen F-W, Campbell P, Ota T. The Effect of Molecular Weight, Calcium Stearate, and Sterilization Methods on the Wear of Ultra High Molecular Weight Polyethylene Acetabular Cups in a Hip Joint Simulator. J Orthop Res 1999;17:329-339.

2. Stiehl JB, St. John KR, Afflitto R, Poggie RA. Improved Wear Resistance of Compression Molded Cross-Linked Polyethylene. Scientific Exhibit, American Academy of Orthopaedic Surgeons, San Francisco, CA, February 28-March 4, 2001.

3. St. John KR. Evaluation of the Wear Properties of a Metal-on-Metal Total Joint Replacement System and in vitro Macrophage Response to Resultant Wear Particles. Doctoral Dissertation, Mississippi State University, 2001.

4. St. John KR, Poggie RA, Afflitto RM. Characterization of Wear, Frictional Torque, and Metal Ion Release for Precision Metal-on-Metal Hip Bearings. 27th Annual Meeting, Society for Biomaterials, St. Paul, MN, April 24-29, 2001.

5. St. John KR, Poggie RA, Zardiackas LD. Comparison of Two Cobalt-Based Alloys for Metal-on-Metal Hip Bearings: The Relationship Between Hardness and Pin-On-Disc Wear, Symposium on Cobalt-Base Alloys for Biomedical Application, ASTM Committee F-4, Norfolk, Virginia, November 3-4, 1998.

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