FRICTION, WEAR, AND MACHINABILITY USER CENTER

at the High Temperature Materials Laboratory (HTML)

FWMUC

The Friction, Wear, and Machinability User Center (FWMUC) is one of six User Centers that comprise the High Temperature Materials Laboratory (HTML). The HTML facilities are within the Metals and Ceramics Division at the Oak Ridge National Laboratory, near Knoxville, Tennessee.

Our mission is to provide a collaborative environment for performing research on the response of materials to friction- and wear-causing environments and on the machining characteristics of materials, especially difficult-to-machine materials like ceramics and composites.

Our vision is to be a national resource for solving technology-enabling problems that concern the friction, wear, lubrication, and machining characteristics of high-performance materials. Applications include transportation, energy production, manufacturing, and medical devices.

Friction and Wear Studies

Selecting appropriate materials, surface treatments, coatings, and/or lubricants for friction- and wear-critical applications can present a formidable challenge for designers and material developers. The path to a solution often involves laboratory rig testing, data collection, and subsequent surface analysis. Experienced FWMUC staff members initially consult with users to help select the best approach to their specific friction or wear problems, whether they involve basic research or are applied to specific types of machinery. ORNL's experience in friction and wear research spans over a quarter century and encompasses a wide variety of materials, including ceramics, metal alloys, carbon materials, composites, solid lubricants, polymers, and intermetallic alloys. Customized test apparatus can simulate various forms of wear and different kinds of frictional contact environments.

Testing Capabilities

- Low- and high-speed pin-on-disk friction and wear test systems
- Instrumented scratch testing and hot hardness testing
- High-temperature friction and wear testing up to 1000°C
- Abrasive wear and repetitive impact testing
- ASTM standard test methods G-99, G-133, G-174, and G-181

This rotary test system was modified to simulate the wear of automotive transmission fluid gerotor pump parts.

More than 15 kinds of friction and wear testing configurations are available. Supporting instruments include a mini-viscometer, microindentation hardness tester, surface profiling instruments, and a Hysitron Triboindenter. Past user projects have ranged from assessing wear of diesel engine components to measuring the friction of polymers and special surface treatments for dental drills. Tribology staff expertise combines backgrounds in materials science and mechanical engineering to offer a multidisciplinary approach to tribology problem solving.

Setting the Standard

Over the years, ORNL has led the development of four new ASTM standards for wear and friction testing and has participated in the development of numerous others. The use of standards, where applicable, helps ensure the repeatability of our data and the ability to compare our results with past work. We recognize the importance of understanding the characteristics of a test method in order to more fully understand the implications of its results.

Machinability

Machinability is the ability of a material to be machined cost-effectively by processes like grinding and turning and also concerns the surface quality that results from those operations. Therefore, machinability includes such factors as machine tool–workpiece interactions, grinding media and tool wear, optimization of material removal rate, and the measurement of surface quality attributes like form, finish, and subsurface damage.

Several numerically controlled grinders are available for research projects in the FWMUC. These grinders were selected for their similarity to those used in manufacturing facilities throughout the United States. Instrumentation has been added to permit real-time measurement of grinding forces, spindle power, spindle vibration, acoustic emission, and coolant temperature. Data may be collected, displayed, stored, and analyzed using specialized LabVIEW programs and other analysis software.

The K. O. Lee Vigor CNC creep-feed grinder is available for user projects. This precision grinder is fully instrumented to facilitate data collection and analysis. The machine features a horizontally mounted, high-speed, variable-speed spindle, fully enclosed hood, large work table with an electromagnetic chuck, and a NUM Model 1040 controller with conversational programming capabilities.

Instrumented K. O. Lee creep-feed grinder

Other Machining Capabilities

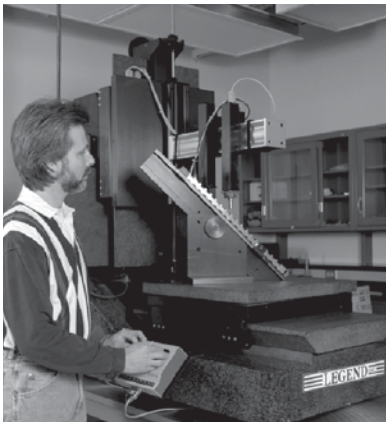
- Weldon cylindrical grinder
- Precitech high-precision diamond turning machine
- Chevalier CNC surface grinder
- Cincinnati Sabre multi-axis grinder with high-speed spindle

Machining Support Software

- SmartCAM production turning and milling packages
- DADiSP (data analysis and display software)
- ReLink data playback software
- Statistica (statistical analysis software)

Dimensional Metrology Instruments

The FWMUC maintains state-of-the-art dimensional metrology and surface texture measuring equipment to assist HTML guest researchers in characterizing their samples. Our highly qualified technical staff is available to assist researchers in the operation of the more complex equipment, such as the coordinate measuring machine and the atomic force microscope.



The Electronic Measuring Device's Legend coordinate measuring machine

Other Metrology Capabilities

- Contact (stylus) and noncontact (laser) surface topography measurement instruments
- Image analyzer for high-magnification feature measurements
- Hysitron Triboindenter with topography scanning capabilities
- Scanning acoustic microscope for detecting subsurface flaws

Most of the metrology instruments are computer controlled, and data can easily be exported to advanced analysis software. Users are provided with image files for use in presentations and publications.

Overall, the FWMUC is a unique national resource that supports advances in materials science and technology by providing expertise in tribology, metrology, and machining.

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