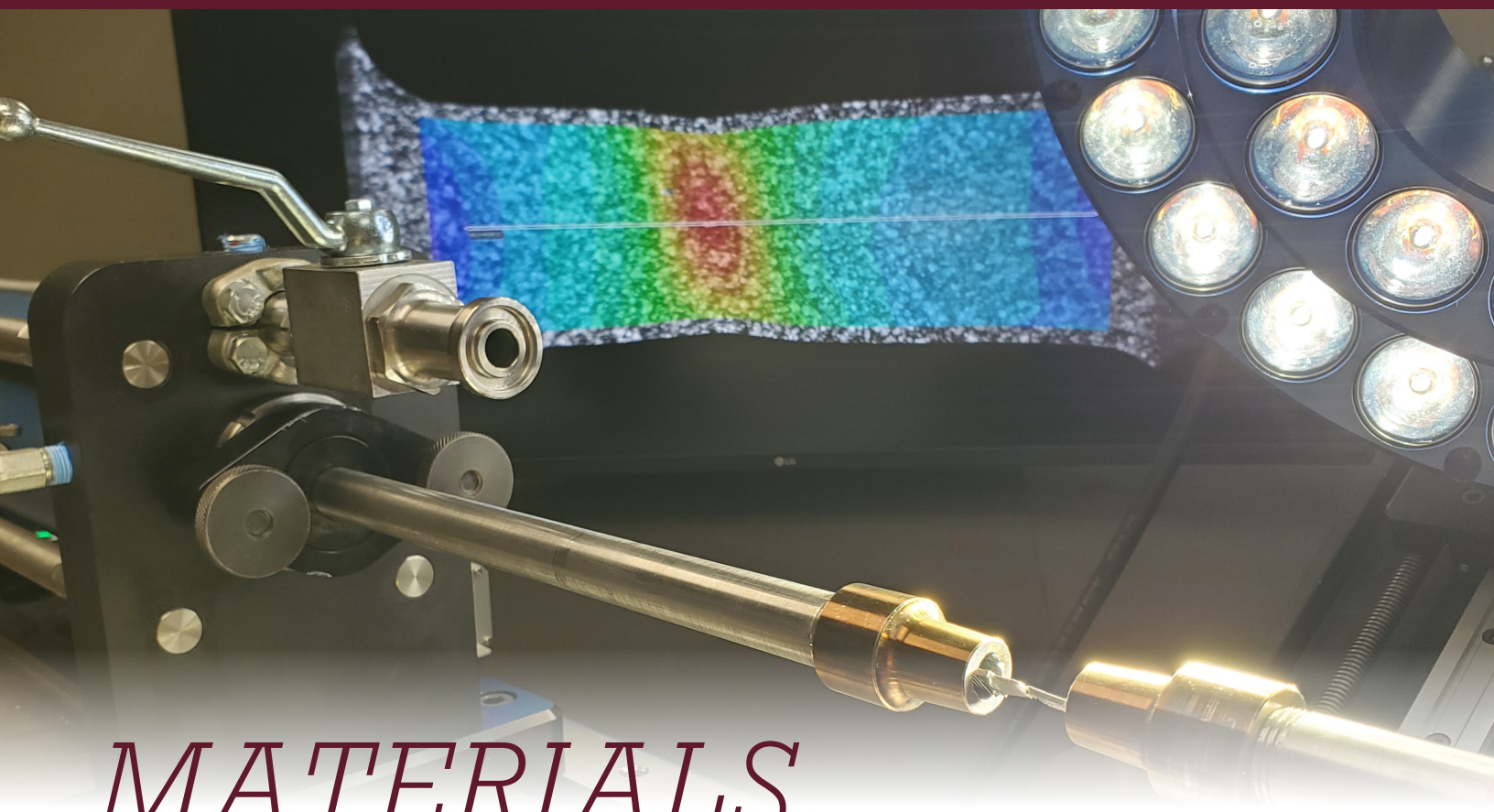
MISSISSIPPI STATE UNIVERSITY™
CENTER FOR ADVANCED
VEHICULAR SYSTEMS



MATERIALS TESTING AT CAVS

ABOUT

Materials research at CAVS spans testing, characterization, and multiscale modeling at the production, processing, and component levels. Experimental aspects include conventional as well as advanced manufacturing, thermomechanical process development, mechanical testing, and microstructure characterization. Monotonic mechanical behavior of metallic and non-metallic materials can be measured at strain rates on the order of 10^{-5} - 10^{4} s^{-1}, while cyclic behavior can be assessed under tension, compression, shear, or combined loading. Thermomechanical testing enables temperature control rates up to 10,000°C/s coupled with environmental control as well as axial and/or torsional deformation. MSU is also equipped to observe material behavior under hypervelocity impact loading. Additional capabilities include non-destructive evaluation, material extraction, chemical analysis, corrosion testing, indentation, and formability.

CAPABILITIES

NON-DESTRUCTIVE EVALUATION

- Ultrasound *(Olympus Glider scanner + 5L64 probe)*
- Eddy current *(JENTEK jET)*
- X-Ray computed tomography *(Nikon XT H225 ST)*
- Surface profilometry – laser *(Talysurf CLI-2000)* & optical *(Keyence VR5000)*

DENSITY MEASUREMENT (GAS PYCNOMETRY)

ANTON PAAR ULTRAPYC 5000

- Temperature: 15 - 50°C
- Cell Sizes: 0.25 - 4.5 cm^3
- Accuracy: ±0.1%, Repeatability: ±0.05%

PARTICLE SIZE ANALYSIS (LASER DIFFRACTION)

HORIBA PARTICA LA-950

- Wet or dry samples
- Size range: 10 nm - 3 mm
- Std. Tolerance: ±0.6%, Coeff. Of Variance: ±0.1% (vs. NIST std.)

MACHINE SHOP

- Waterjet *(OMAX Maxiem 1515)* & wire EDM *(Makino UX6)*
- CNC machining *(Haas VF5 mill & Haas SL-20 lathe)*
- Manual mills, lathes, bandsaws, brake, shear, surface grinder
- Welding (MIG and TIG)

MECHANICAL TESTING

WITH ELEVATED TEMPERATURE

- Instron Electromechanical – max.50/100 kN axial, 350°C
- Instron Servo-hydraulic – max. 300 kN axial + 3,000 N-m torsional, 350°C
- MTS Servo-hydraulic – max. 100 kN axial, 1,000°C or 25 kN axial + 250 N-m torsional
- Correlated Solutions 1-camera (2D) and 2-camera (3D) Digital Image Correlation (DIC)

HIGH-RATE MECHANICAL TESTING

- REL split Hopkinson pressure bar with MSU-patented serpentine technology
  - Tensile strain rate: ~10^3/s
  - Tensile material thickness: 0.02 - 0.125 in.
  - Photron Fastcam SAZ high speed cameras for 2D and 3D DIC (max. 480,000 frames/sec)
- Hypervelocity two-stage light gas gun
  - Projectile slug velocity: 3 - 6.25 km/s
  - Specimen size: 2×2 in. up to 3×3 ft.
  - Laser speed measurement
  - Kirana high-speed camera for impact recording (max. 1,000,000 frames/sec)

METAL FORMABILITY

INTERLAKEN SERVOPRESS SP150

- Tooling for hole expansion, Nakajima, Erichsen (with option to add Fukui, Marciniak, Bulge die, or custom)
- 667 kN (150 kip) clamp force, 511 kN (115 kip) punch force, 400 mm/s (15.75 in/s) punch velocity
- Frame for 2-camera 3D digital image correlation (DIC)

CHEMICAL COMPOSITION

- Optical emission spectroscopy *(SpectroMAXx with Fe, Ti, Al, Mg, Ni modules)*
- Carbon/sulfur gas combustion analysis *(LECO CS744)*
- Energy dispersive x-ray spectroscopy *(Bruker XFlash 4030)*

CORROSION TESTING

Q-LAB Q-FOG CCT600

- 640L Chamber (160 test panels, 75×15 mm each)
- 120L Reservoir (>7 days of corrosive solution)
- Conventional salt spray, 100% humidity, Prohesion, Copper-Accelerated-Acetic-Acid Salt Spray (CASS)

HARDNESS

- Brinell – tabletop *(King AK-37)* & portable *(Ernst)*
- Vickers – automated *(Wilson VH 3100)* & manual *(LECO LM300)*
- Rockwell *(LECO LR300)*
- Nanoindentation *(Hysitron TI950 Triboindenter)*

PROFILOMETRY-BASED INDENTATION PLASTOMETRY

PLASTOMETREX

- Tensile response from hemispherical indent in ~5 mins.
- Effective for functionally graded materials and high-throughput testing
- Min. sample size: 1.5 mm thick, 3×3 mm area
- High-temperature capability (max. 800°C)

THERMAL-MECHANICAL SIMULATION

GLEEBLE 3500

- Electrical resistance heating of conductive samples up to 1700°C
- Heating and cooling up to 10,000°C/s (air, water, gas, mist quench capability)
- Controlled atmosphere: air, vacuum (down to 10^{-8} Torr), inert gas, or custom gas mix
- General Purpose, Hot Torsion, Hydrawedge MCUs

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INTERESTED IN MATERIALS TESTING AT CAVS? CONTACT DR. HONGJOO RHEE, ASSOCIATE DIRECTOR FOR ENGINEERING MECHANICS AND MATERIALS SCIENCE.

hrhee@cavs.msstate.edu 662.325.5431

Clay Walden
Executive Director • CAVS
walden@cavs.msstate.edu

Hongjoo Rhee
Associate Director • Engineering Mechanics & Materials Science
hrhee@me.msstate.edu

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