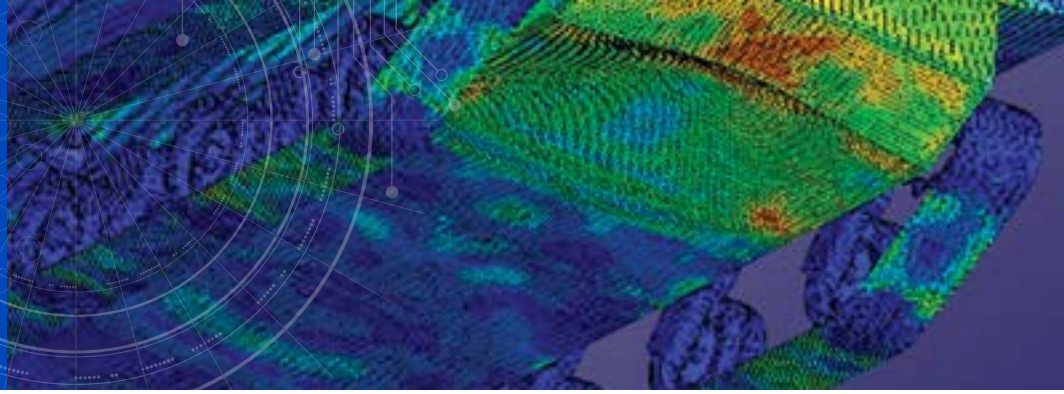
SwRI®

Southwest Research Institute



Characterization of Dynamic Material Response

The performance of materials at high strain rates is of interest for various applications (e.g., structural, military and sports). Southwest Research Institute® (SwRI®) has a long history in characterizing the high strain rate response of materials. The SwRI High Rate Test Laboratory housing the Split-Hopkinson pressure bar apparatus has been designated an ASME Historic Mechanical Engineering Landmark, based on pioneering work in the 1960s that allowed direct generation of the complete stress-strain curve for a single impact.

The SwRI High Rate Test Laboratory is equipped with instrumentation for measuring, recording and analyzing test data for strain rates approaching 5000 s^{-1}. High-speed imaging systems are available to record the high rate response. Lab capabilities include high rate testing in tension, compression, torsion and three-point bend. Microstructural characterization of tested material can be accomplished to determine deformation and failure mechanisms. The facility is staffed with experienced personnel who can adapt test conditions to meet unique requirements.

Dynamic Test Capability

- Tension (strain rate ≤ 2×10^3 s^{-1})
- Compression (strain rate ≤ 20×10^3 s^{-1})
- Torsion (strain rate ≤ 2×10^2 s^{-1})
- Fracture toughness
- Taylor impact (strain rate ~10^5 s^{-1})

SwRI High Rate Test Laboratory

Materials Testing Experience

- Armor materials
- Blast-resistant materials
- Metals
- Ceramics
- Glass• Rocks and soils
- Powders/granular materials
- Biological materials (tendons, ligaments, bone)
- Porous/foam materials
- Polymers
- Fiber composites
- Fabrics
- Concrete

Materials Characterization

- Deformation response: stress-strain curves
- Strain rate effects
- Failure mechanism determination
- Shear and delamination testing
- Dynamic deformation and displacement measurements
- Fracture
- Constitutive model development
- Determination of Johnson-Cook model constants

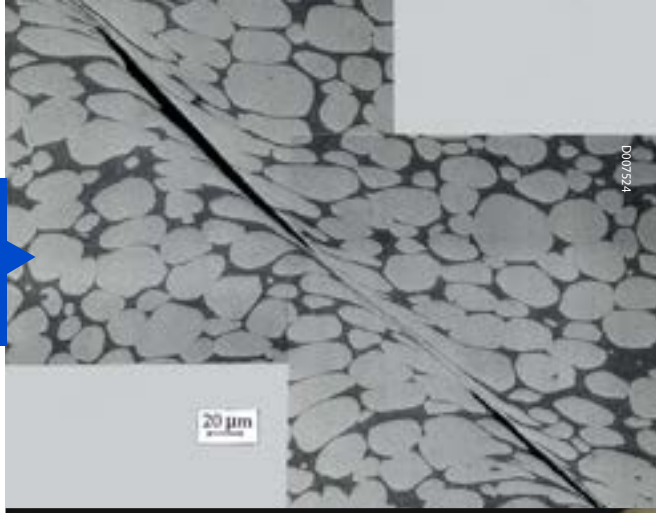
Dynamic mechanical test specimens

Dynamic Test Equipment

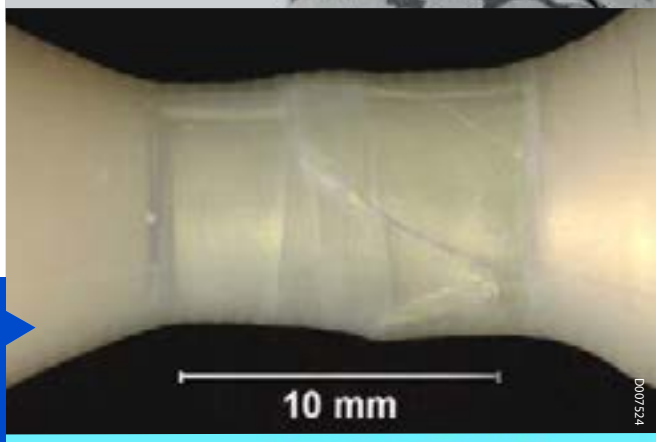
- Split-Hopkinson pressure bar systems
  - Compression
  - Tension (direct, indirect)
  - Environments: vacuum, air, Ar, N
  - High temperature (≤ 1000°C)
- Plate impact facility (equation of state and spall)
- High-speed torsion actuator
- High-speed data acquisition system
- High-speed imaging systems (up to 10^6 frames/second)
- High-speed strain gage amplifiers
- Displacement mapping system for 3-D dynamic strain measurements
- Confining pressure apparatus (≤ 500 MPa)

Support Capabilities and Facilities

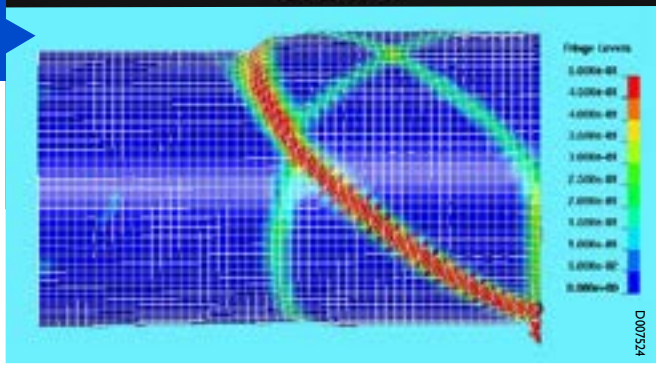
- Numerical simulations of experiments (LS-DYNA, CTH, EPIC)
- Metallurgical laboratory
  - Optical and scanning electron microscopy
  - Energy dispersive spectroscopy
  - Auger spectroscopy
  - X-ray diffraction
- Ballistics and explosives range
- Mechanical test laboratory
  - Low strain rate material characterization
  - Tri-axial compression and extension
  - High-temperature testing
  - Testing in extreme environments
  - Customized testing
- Full-service machine shop



Compressive shear band and associated local microcracking in a tungsten alloy tested at a high strain rate



Shear failure in glass specimen following confined compression testing; damage profile captured with numerical simulation



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