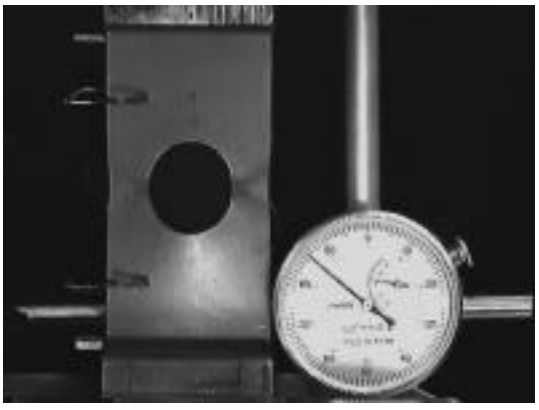
Naval Research Laboratory - Office of Naval Research
Materials Science and Technology
http://mstd.nrl.navy.mil

Science and Technology Success Stories

Constitutive Characterization of Materials

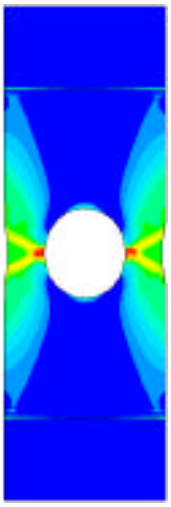
The Naval Research Laboratory (NRL), the Navy's corporate laboratory, has ongoing programs for accurately characterizing the mechanical properties of materials of interest to the fleet. These efforts are motivated by the increasing demands for precise structural response predictions. Research consists of a multi-faceted approach employing both computational simulations and experimental analyses. Standard and novel specimens are tested with appropriate loading to determine physical properties of interest, such as stiffness, strength, ductility, and fracture. Possible imposed loadings are tension, compression, bending, torsion, fatigue, and high-strain-rate. In addition, unique experimental procedures and visualization techniques are being developed for generating and evaluating complex stress fields within relatively simple specimens. Materials that have recently been examined include HY100 steel, TIMETAL® 21S, GASAR and LDC porous metals, and K-Prene 606 polymer.

Experimental setup



FEM mesh

Stress contours



Experimental analysis and computational simulation using a single hole specimen to generate multiaxial stress states in β21S titanium alloy

Constitutive Characterization of Materials

Military Impact

- **Cost-Efficient Techniques for Rapidly Evaluating the Multiaxial Response of New and Existing Material Models with Fewer Tests**
- **Improved Predictive Capability for:**
  - **Structure Response Simulation**
  - **Damage Tolerance (Survivability)**
  - **Lethality**
- **Increased Performance Envelopes for Existing Platforms**

Potential Civilian Spin-offs

- **Improved Evaluation Techniques for:**
  - **Aerospace Structures**
  - **Automotive Structures**
  - **Manufacturing Processes**
- **Database of New Material Properties for Use in Current and Future Designs**

Point of Contact

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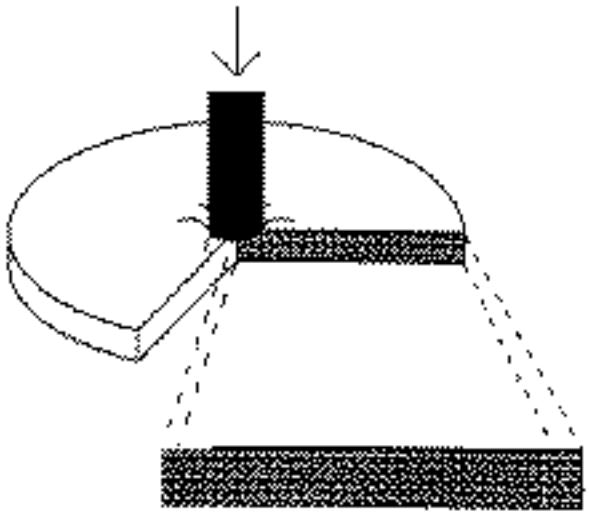
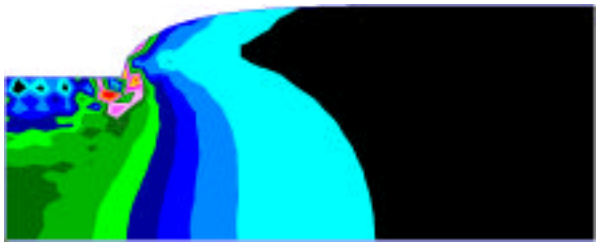
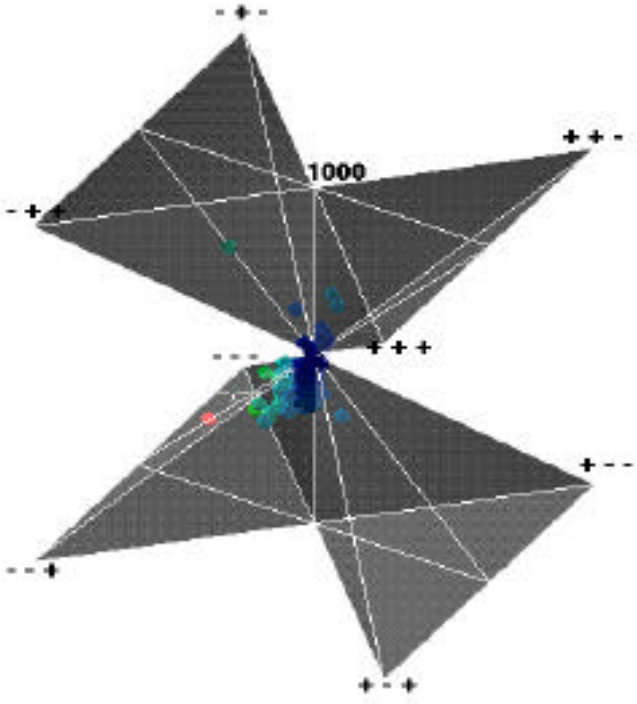


Schematic of indentation test on K-Prene 606 polymer and mesh used for FEM modeling



Mises stress contours from FEM simulations



Frequency plot showing multiaxial stress states present in polymer indentation tests, plotted on 3D stress axes