NRSF2 Load Frame: Design, Control and Testing

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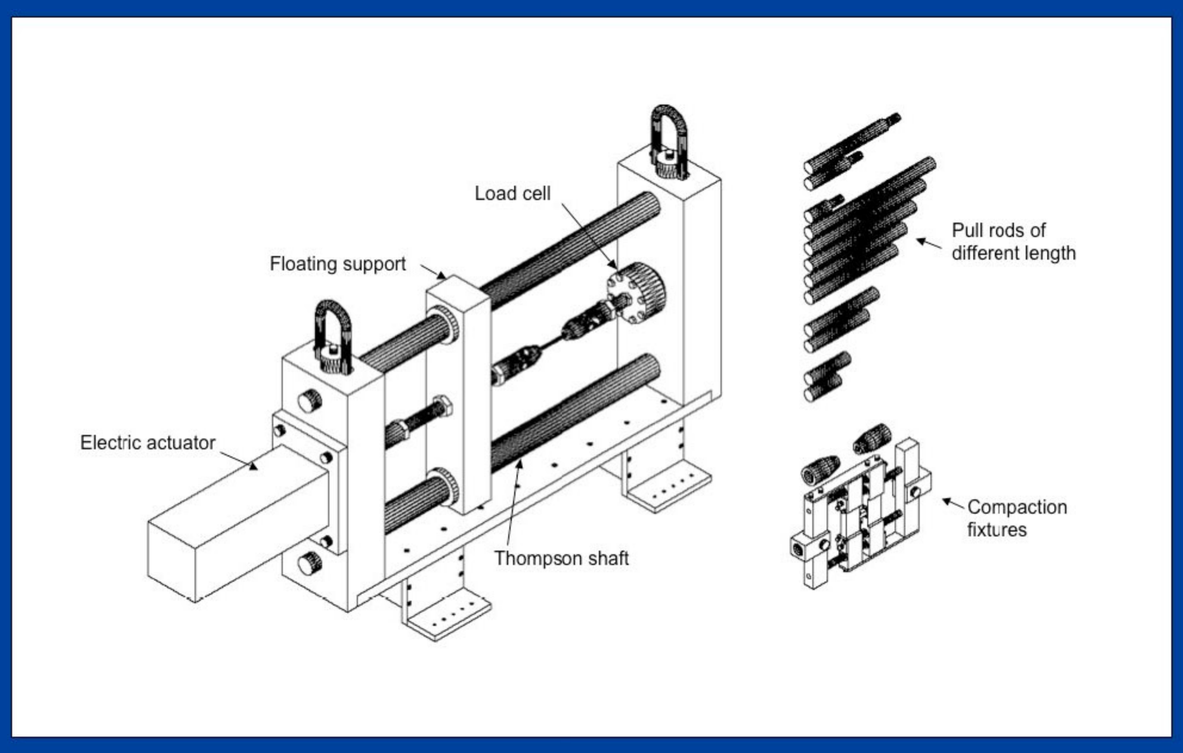
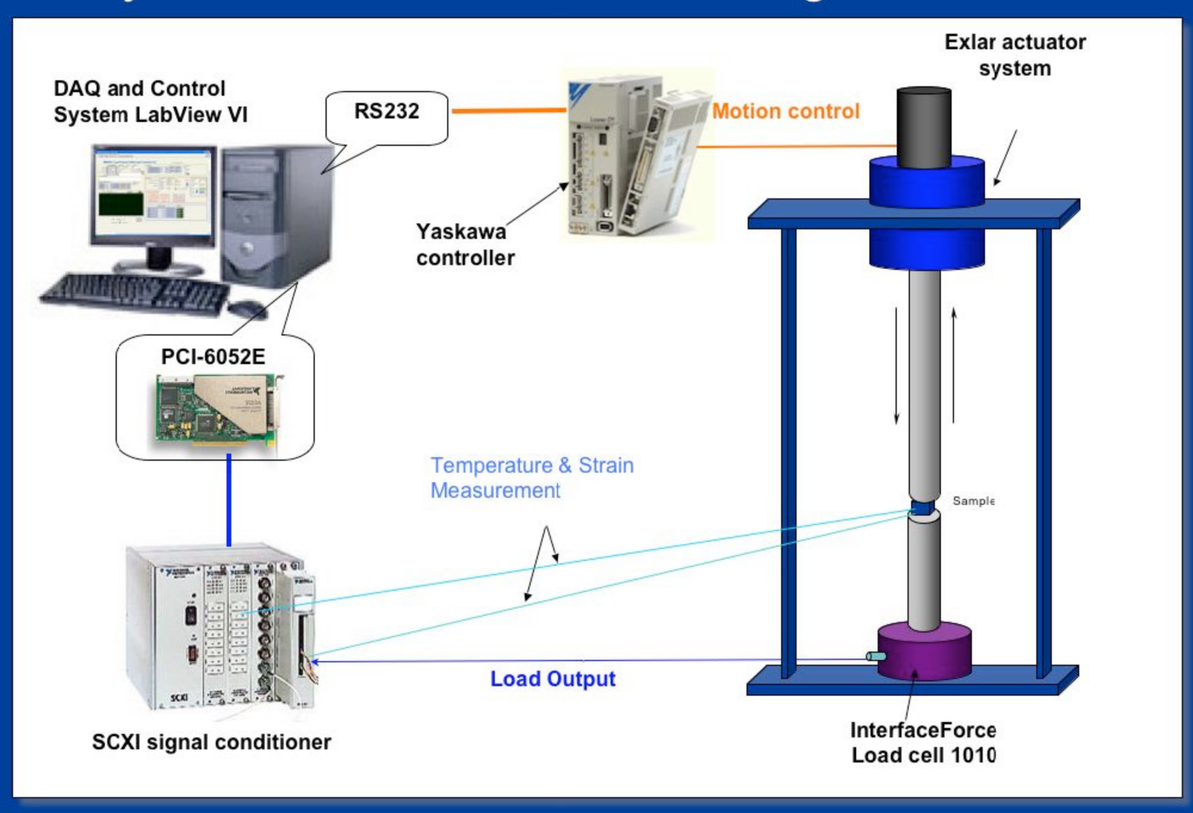
ABSTRACT A neutron diffraction load frame has been constructed for the Second Generation Neutron Residual Stress mapping Facility (NRSF2) at ORNL's High Flux Isotope Reactor (HFIR). The load frame is designed to study micromechanical behavior of materials under applied tensile or compressive load and to characterize specimens with stress risers (e.g. cracks) while under load by taking advantage of the NRSF2 mapping capabilities.

Design and Specifications

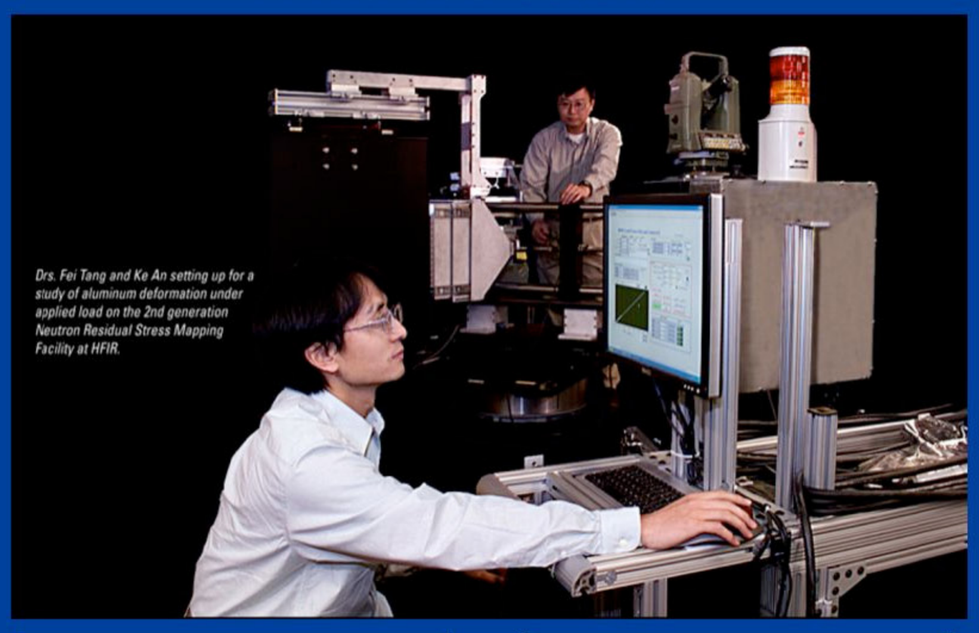


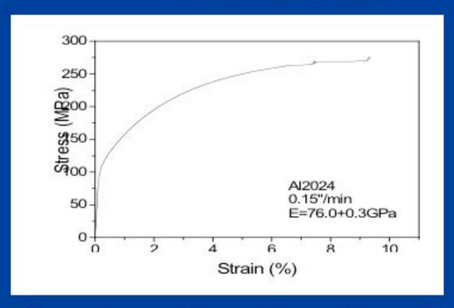
- Linear electric actuator is rated at 22.8 KN (5127 lbs)
- Maximum stroke is about 150 mm (6 inches)
- Strain rate varies from 10^{-6} to 1 per second
- A floating support rides on the Thompson Shafts eliminates use of a long pullrod from the actuator to the grip and optimizes grip alignment
- Typical specimen geometries include uniaxial tension/compression specimens and compact tension specimens
- Load control or displacement control
- Macro strain can be measured using an extensometer, crack opening displacement gauge, or an LVDT
- Force reversal fixture for compaction test using tension

System control and DAQ Configuration



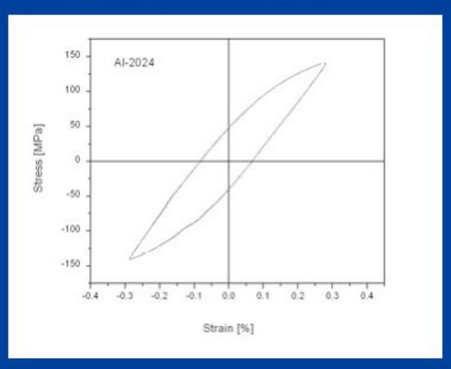
In-situ neutron diffraction of Al 2024 alloy under tensile load



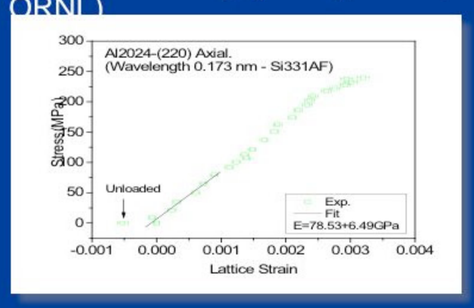


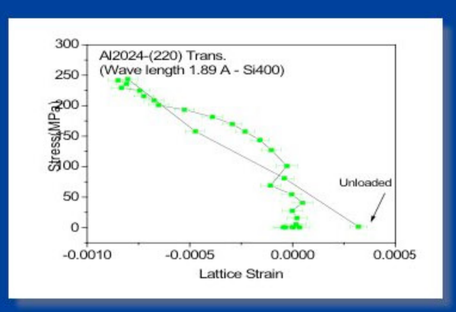
Load Frame	Stress at 0.2% yield point (MPa)	Strain at 0.2% yield point (%)	Young's Modulus (GPa)	Stress at Break (MPa)
MPG	118	0.362	76.9	271
NRSF2	123	0.394	76	275

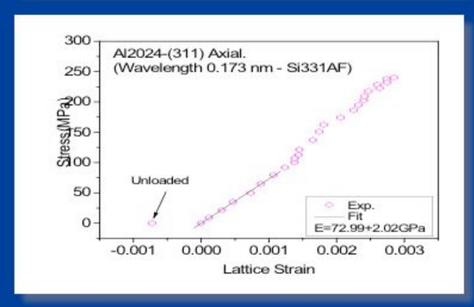
The performance is comparable to standard test results conducted at Material Properties Group (MPG), HTML, ORNL)

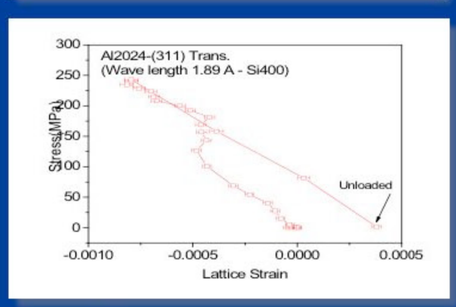


The cyclic loop of the Al2024 alloy shows the capability for in-situ neutron measurement of material fatigue using the load frame

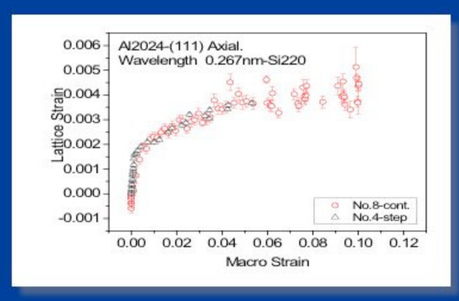


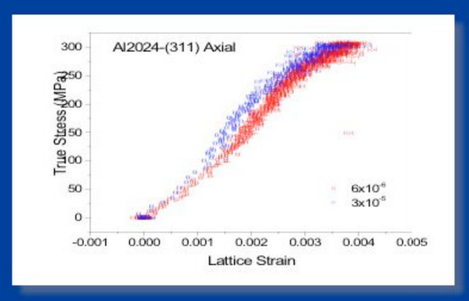






Axial and transversal lattice strains for two hkls were measured by choosing different wavelengths.





Fast neutron data collection (15s/profile) during continuous loading yields good results when compared to traditional data collection (2 min/profile) under step loading (left); lattice strains rate dependency was investigated under continuous loading (right).

Conclusion

The load frame designed for NRSF2 expands the use of the neutron diffraction at HFIR to a broad range of studies of materials deformation behavior.

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