Residual Strains Under Torsion Using Hollow Cylinder Steel Specimens and Neutron Diffraction

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1. Background and Motivation

- Use of neutron diffraction for studying residual strains under tension has been well studied in the past four decades. However, the study of residual strain due to pure torsion or a combination of axial loading and torsion has not been reported in the past literature.
- This study was performed to evaluate the role of torsion in residual strain evolution for hollow cylinder specimens. Torsion provides unique opportunity to probe mechanical behavior of materials under pure shear stress, and in combination with axial load, provides a mechanism to rotate principal stresses in a controlled fashion. Thus, complete three dimensional mechanical behavior can be investigated by controlling the major principal stress rotation to characterize anisotropic materials.

2. Experimental Details

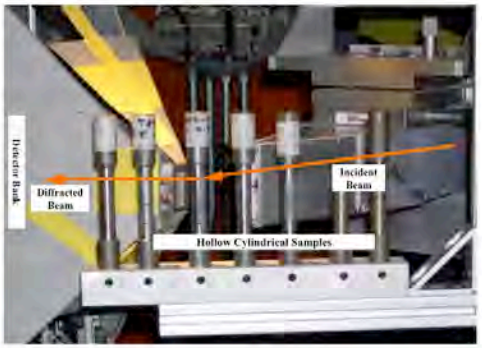
2.1 Materials and sample size

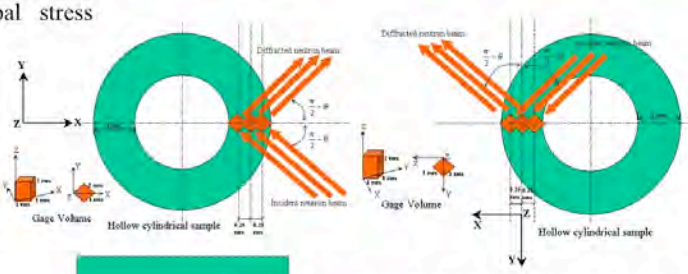
Steel hollow cylinder with outer diameter 10.8 mm, inner diameter 6.8 mm, thickness 2.0 mm.

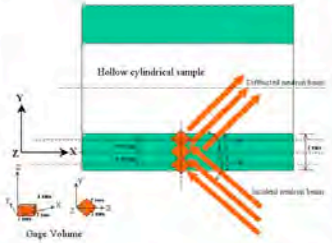
2.2 Tension and torsion tests set-up

Axial and torsional test system (MTS 858 AT)

2.3 NRSF2 set-up







d-spacing measurement in radial, circumferential, and axial directions. Gage volume 1×2×1 mm^3 for radial and circumferential, and 2×1×2 mm^3 for axial.

Acknowledgement

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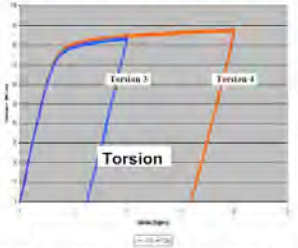
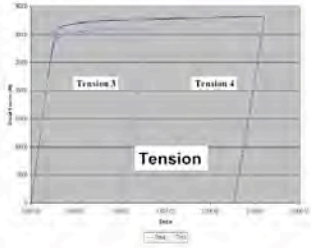
2.4 Neutron diffraction parameters

Monochromators	λ (Å)	2θ (°)	Lattice planes
Si220	2.67	82.23	Fe(110)
Si331AF	1.73	95.37	Fe(211)

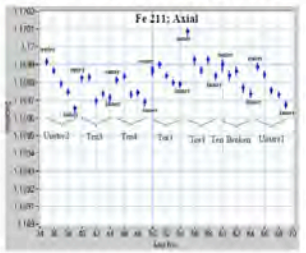
3. Experimental Results

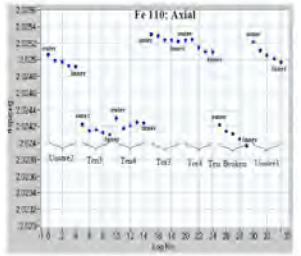
3.1 Laboratory stress-strain history





3.2 Residual strains by NRSF2





4. Summary

- Fe(110) and Fe(211), which have been reported as weakly affected by intergranular strain based on tension tests were used to probe the specimens subjected to pure tension and pure torsion.
- Significant differences were observed for torsion versus tension specimens. Multiple hkl's with SNS would reveal additional information.
- This research demonstrates the need for tension-torsion system at SNS-VULCAN for studying materials under realistic loading conditions.