(NCAL)

Nitinol Commercialization Accelerator Laboratory

2016-2017 Academic Year

CASE SCHOOL OF ENGINEERING
CASE WESTERN RESERVE UNIVERSITY

About

The Ohio Third Frontier Wright Projects Program has funded a collaborative effort between the Cleveland Clinic, CWRU, University of Toledo, NASA Glenn Research Center, and Norman Noble, Inc. in order to develop a better understanding of the metallurgical processing and mechanical characterization of nitinol for use in biomedical and aerospace applications. Biomedical applications range from orthodontia to implantable devices while higher temperature shape memory alloys are of interest for aerospace. The collaboration is designed to create synergy amongst collaborators in the research and development of nitinol products. CWRU is developing a facility wherein the effects of composition changes on mechanical performance can be determined.

The laboratory housed at CWRU's Materials Science and Engineering Department contains processing and characterization (thermal and mechanical) equipment that allows for the manufacture and analysis of nitinol products.

The CWRU campus community can access the facility via the use of a valid CWRU university account number that will be charged at an internal rate for machine time, including set up and any technician time involved. Long term testing can be provided at pro-rated charges in consultation with the Laboratory Director(s). Arrangements can be made to train users on the equipment and reserve time for equipment use. Outside (i.e. non-CWRU) users can access the facility via a number of different mechanisms by contacting the Laboratory Director(s).

Nitinol Commercialization Accelerator Laboratory (NCAL)
Case Western Reserve University
Charles M. White Metallurgy Building
Room 300

Mechanical Characterization

Rotating Bending Fatigue

Positool Model 100

- R = -1
- Test frequency: 60 Hz
- Bend radius: 2 – 127 mm
- Wire diameter: 0.05 – 1.0 mm
- Automatic break detection
- High cycle fatigue

Rotating Bending Fatigue

Positool Model 401

- R = -1
- Test frequency: 60 Hz
- Bend radius: 7.24 – 76.2 mm
- Wire diameter: 0.05 – 1.0 mm
- Automatic break detection
- Wet or dry testing
- High cycle fatigue

Video Extensometer

UVID Enterprises, LLC. Arion 1-D

- Non-contact extensometry
- Localized strain determination
- Frame rate: Up to 60 FPS
- Ideal for wire, film, tissue

Arion 1-D System

- Axial measurements
- Scalable to ±100% elongation
- Resolution: 0.01%

Arion 2-D System

- Axial, transverse, and shear
- Poisson's ratio
- Scalable to ±100% elongation
- Resolution: 0.01%

Processing Equipment

Vacuum Arc Melting

Thermal Technology LLC Model BJ5 Arc Melter

- Maximum temperature: 2000°C
- Hearth: Water-cooled Cu 9" OD
- Bell jar: Stainless steel, water-jacketed 10" ID x 11.5" high
- Casting: Typical sizes range from 0.5" – 3.0" diameter
- Operating vacuum: 10^{-2} torr
  Ultimate vacuum: < 10^{-5} torr

Vacuum Heat Treatment

Centorr/Vacuum Industries Series 2110 Super VII

- Stainless steel (Type 304) inner chamber, double wall stainless steel jacket and flanges, fully water baffled, 20" ID x 30" long
- W-rod elements, Mo-radiation shields and hearth plate
- Maximum temperature: 1600°C
- Ultimate vacuum: 10^{-6} torr range

Hot Extrusion

Innovare, Inc. LES Explorer Series

- Maximum temperature: 900°C
- 100,000 lb force
- Billet diameter: 0.5" max
- Extrusion dies: 1/4", 5/16", 3/8"
- Extrusion Rate: 0.5" - 1.0"/min
- Additions for Phase II: Advanced Metalworking System (AMS)
- 400,000 lb force apparatus

Characterization Equipment

Differential Scanning Calorimetry

Netzsch 404 F1 Pegasus High Temperature DSC

- Temperature range: 25-1500°C
- CP range: 25-1400°C
- Heating rate: 0.1-50 K/min
- Enthalpy range: 0-30000 J/g
- Specific heat: 10-5000 J/kg·K
- Platinum furnace
- Thermocouple: Type S
- Protective gas: Argon

Mechanical Characterization

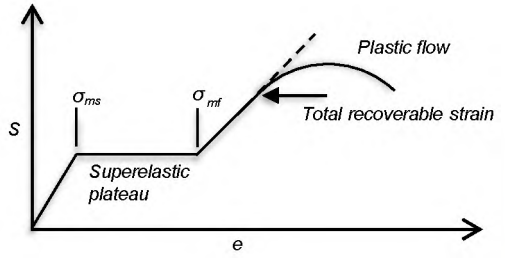
Flex Bending Fatigue

Universal Model 3FDF Fatigue Tester

- R = -1
- Test frequency: 1-17 Hz
- Mandrel sizes: 1-24 mm
- Automatic break detection
- Constant strain amplitude
- Low cycle, high cycle fatigue

Superelastic Nitinol in Tension

- Strain rate: 1 x 10^{-3}/s
- Wire diameter: 355-508 µm
- Recoverable strain: < 8%
- Ductile failure



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Ohio Third Frontier
Innovation Creating Opportunity

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Cleveland Clinic