



Prenscia Technology Days

Virtual Seminar Series – Tuesday 2, 9, 16 November



Mechanical Testing Capabilities at the Prenscia AMCT Facility

Presented by Dr. Michelle Hill
*Head of Materials Testing
Prenscia (HBK)*

Tuesday, November 16, 2021

Mechanical Testing Capabilities at the Prenscia AMCT Facility

Abstract

The Prenscia Advanced Materials Characterization & Test facility (AMCT) is located in Rotherham, United Kingdom. Conducting materials testing for over two decades, the AMCT facility is focused on providing customers with fully characterized and interpreted material parameters ready for use in mechanical finite element analysis and/or fatigue analysis. Testing services offered include:

- Tensile and compression tests with determination of basic mechanical properties
- Strain-controlled axial fatigue tests for Basquin, Coffin-Manson, Smith-Watson-Topper and Ramberg-Osgood curves with full evaluation of regression and design curves
- Load-controlled axial fatigue tests for Basquin curves with full evaluation of regression and design curves
- High temperature tensile and fatigue tests in strain or load control between -40 to 900°C.
- Analysis of iso-thermal stress-life (SN) and strain-life (EN) curves or analysis of advanced Chaboche thermo-mechanical fatigue properties
- Fatigue crack growth testing and generation of da/dN curves and calculation of ρ^* at ambient conditions
- Torsional fatigue testing for generation of Wohler curves and 'staircase' testing at ambient and elevated temperatures
- Fatigue testing of sub-element specimens, jointed materials or assemblies in axial, bending or custom tests

Material types include metallics, engineering polymers, composites, civil engineering elastomeric materials and joining materials. With in-house design and manufacture of fixturing and full specimen preparation from raw material or components, and testing conducted to recognized standards, in-house customer standards or development of bespoke test methods for advanced materials and components.

About the presenter, Dr. Michelle Hill, Head of Materials Testing, Prenscia (HBK)

Michelle holds a Master's degree in Aeronautical Engineering and PhD studying the damage resistance and tolerance of composite sandwich structures, obtained from Loughborough University. She joined HBK in May 2017, having previously held the position of Chief of Materials at the Rolls-Royce CTAL facility on the Isle of Wight. Her speciality is in composite materials characterisation and testing, with hands on experience in defining and executing large material qualification programmes. Having spent 10 years on the Rolls-Royce composite fan system programme, leading the Materials team, Michelle has experience of how to relate materials testing to real applications and how to characterize difficult structures such as hybrid joints. At HBK she is responsible for the AMCT facility and the management of the commercial testing activities along with research into the fatigue behaviour of additively manufactured materials and composites.

Mechanical Testing Capabilities at the AMCT Facility

Presenter: Dr Michelle Hill

16th November 2021



Introduction to the AMCT

FOR THOSE OF YOU WHO HAVEN'T VISITED!

AMCT – Advanced Materials
Characterisation and Testing

Based at the Sheffield site in the UK

Team of 6 people

13 axial rigs and one torsion rig

FATIGUE IS OUR DAY JOB!!



Materials Testing Methods Available at the AMCT

Static Testing

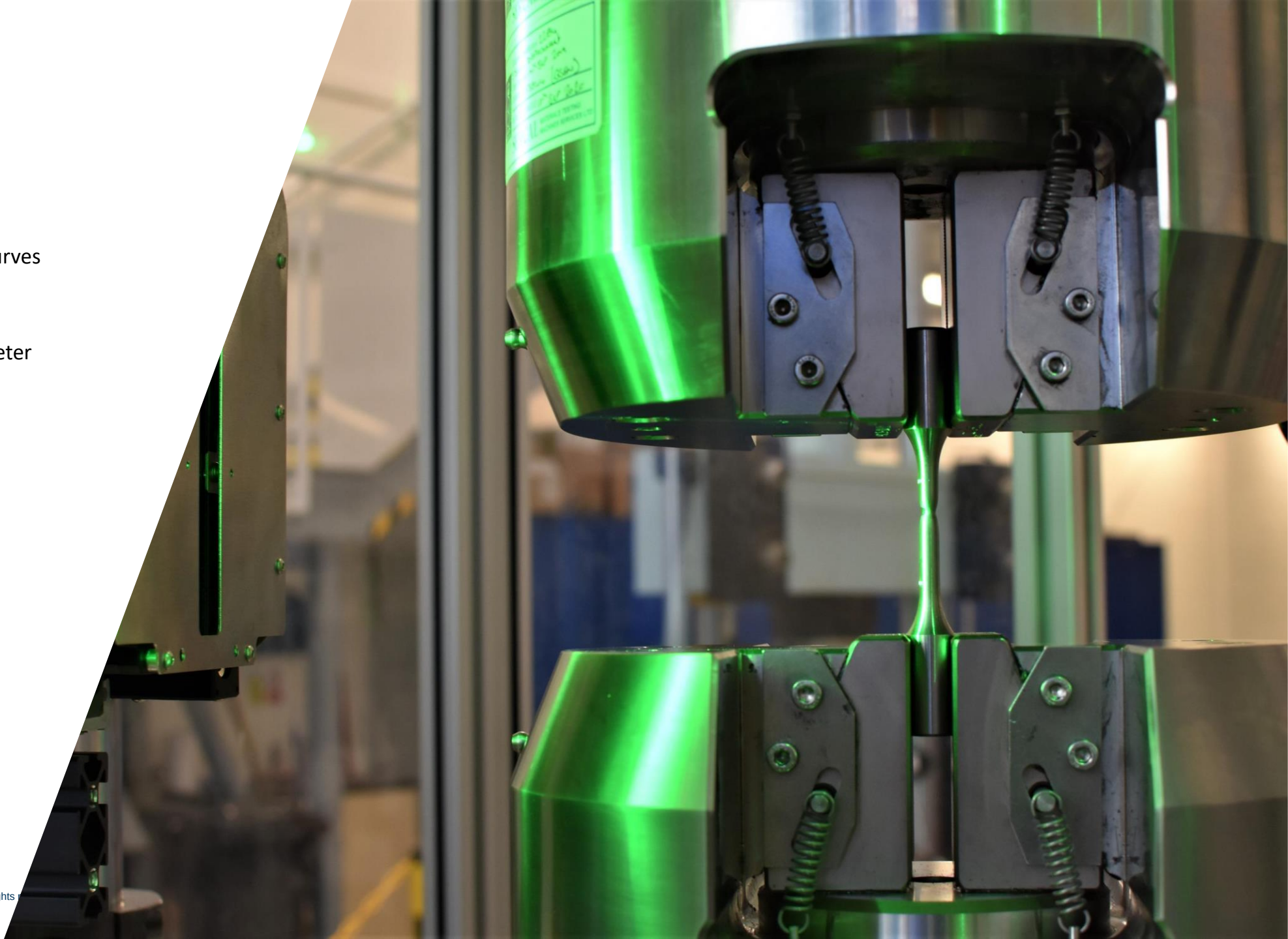
TENSION

- Monotonic stress-strain curves
- Cyclically stabilised stress-strain curves
- Non-contacting extensometer to capture strain to break

COMPRESSION

LAP SHEAR

3 OR 4-PT BENDING



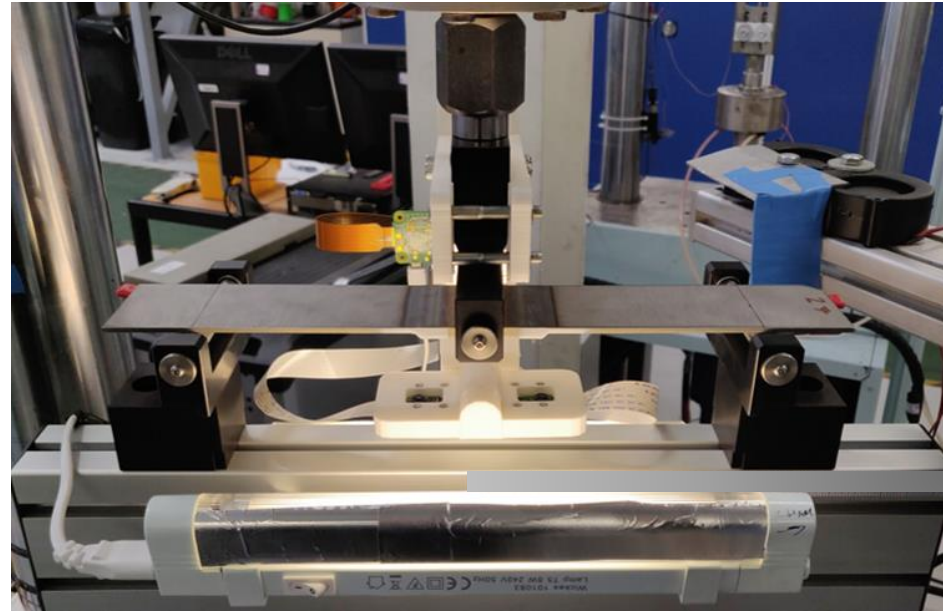
Stress-Life Fatigue

Axial loading

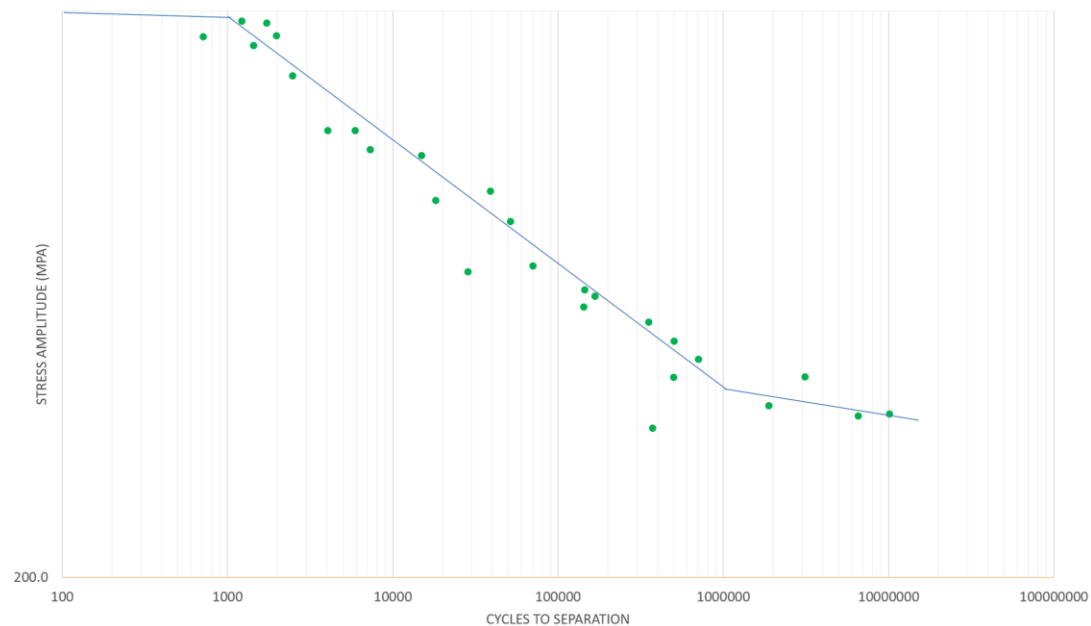
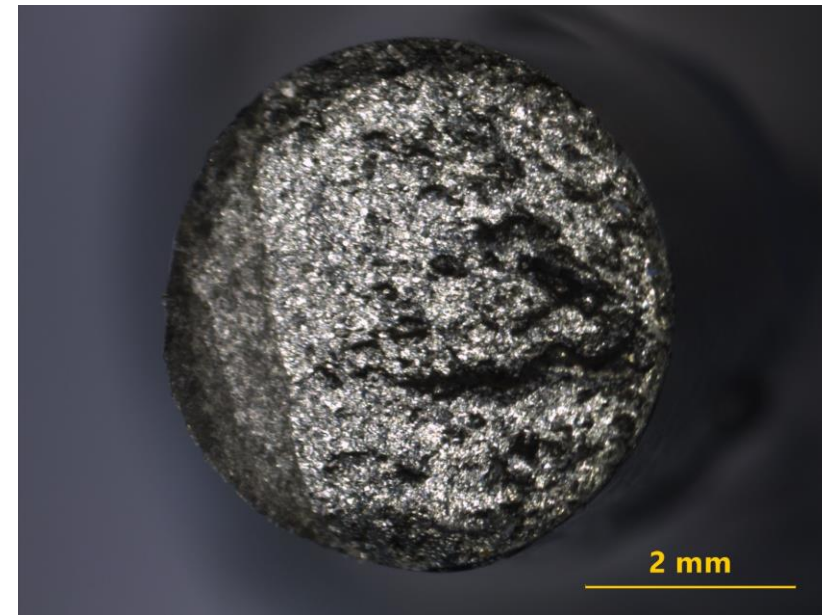


$R = -1, 0.1, 0.5, -0.5, 10$ etc

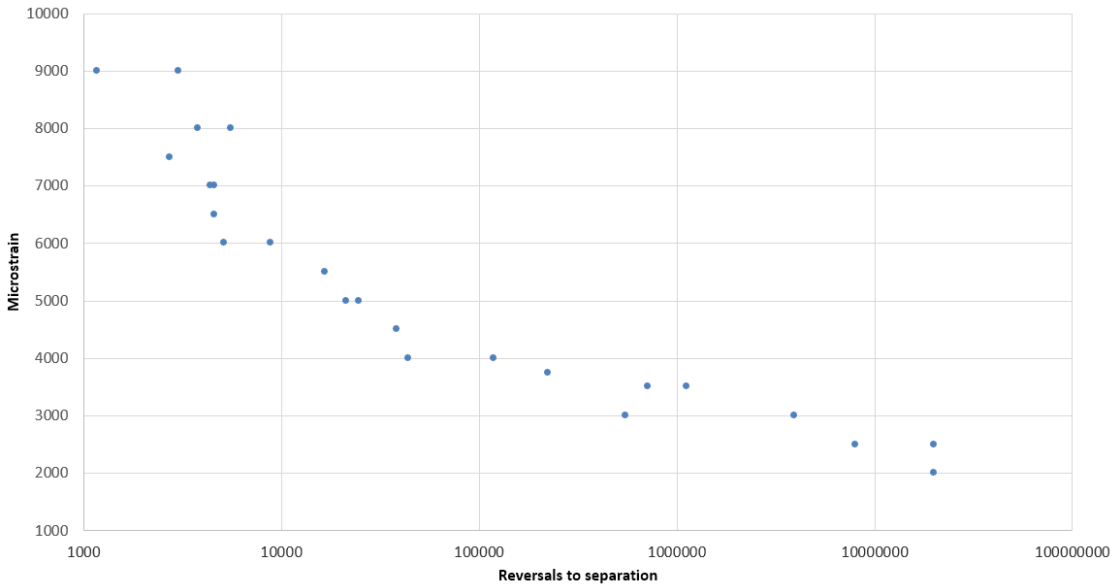
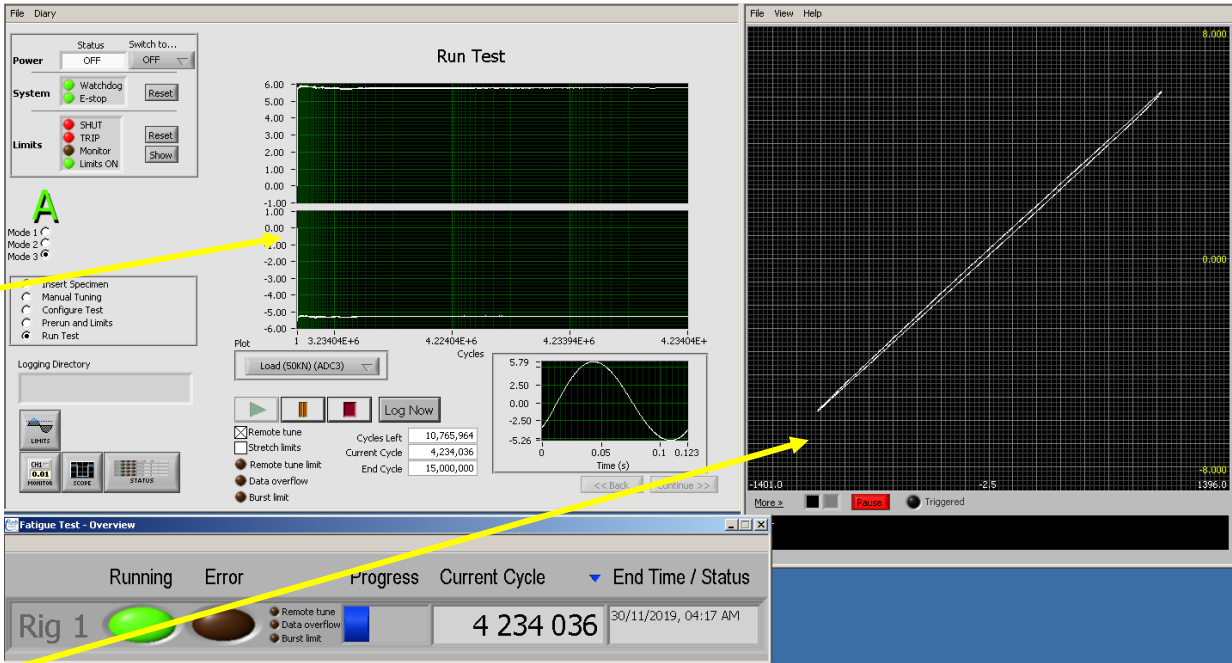
3- or 4-point bending



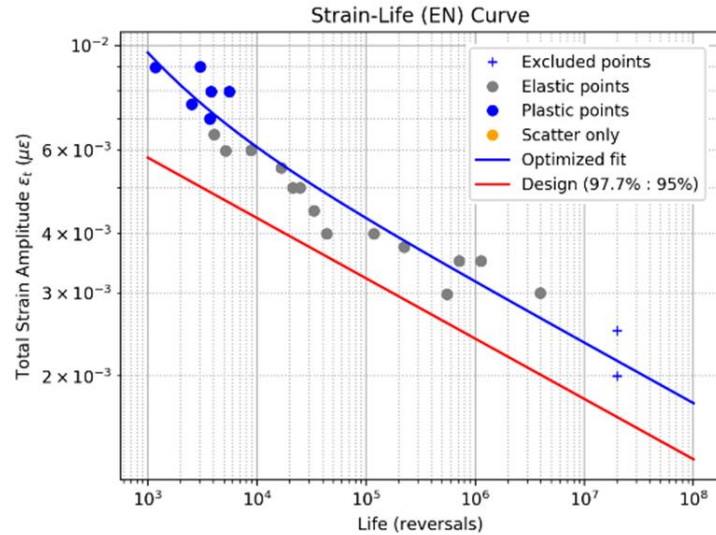
Optical microscopy of fracture surfaces



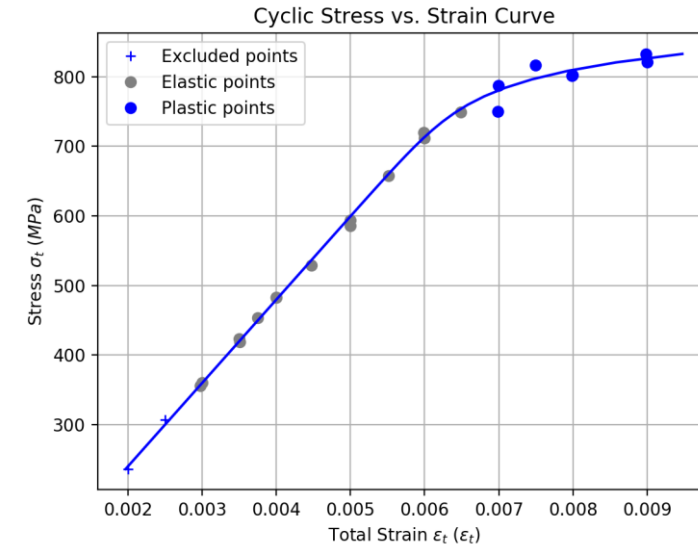
Axial Strain-Life Fatigue



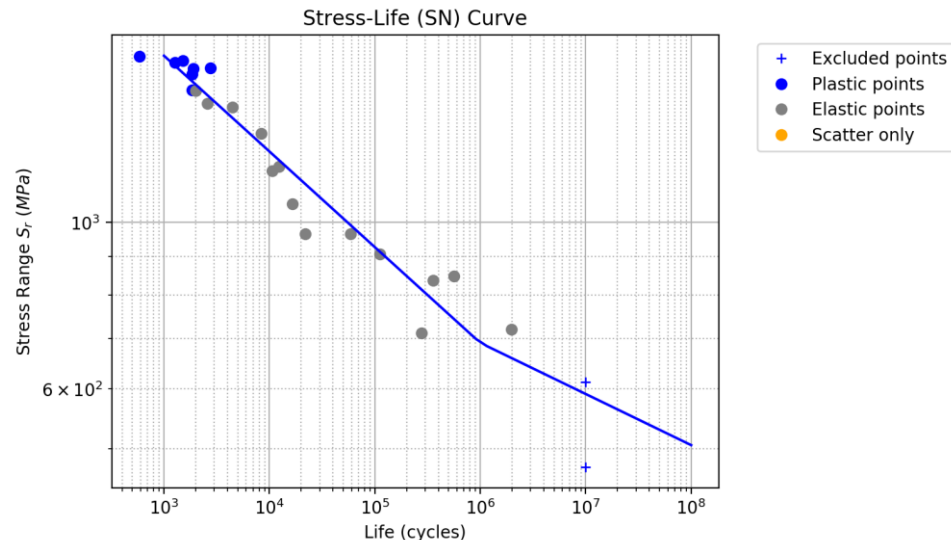
Strain-Life Fatigue Parameter Generation



EN curve fit for regression and design curves



Generation of Ramberg-Osgood cyclic stress-strain curve

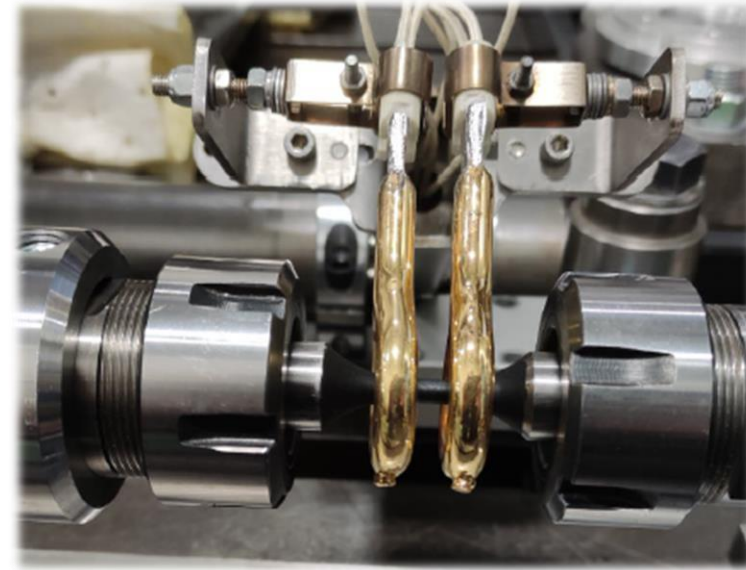
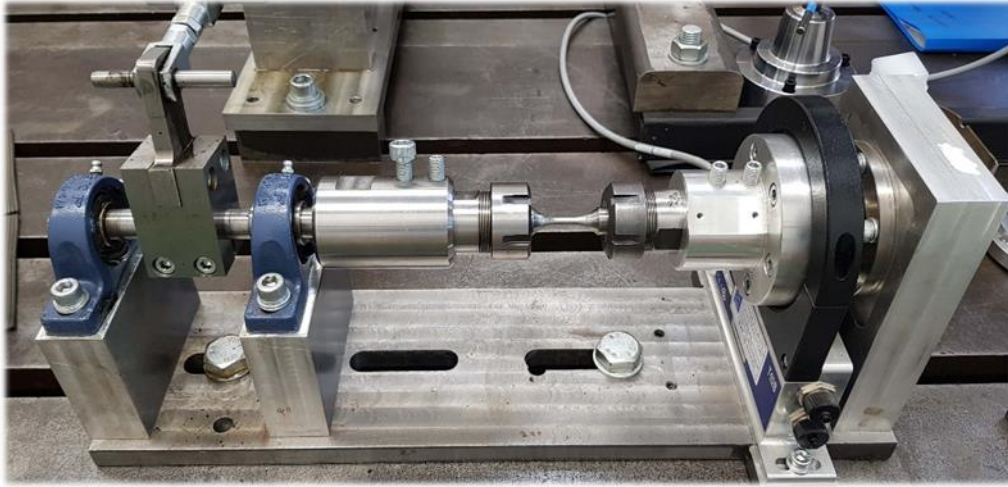


Derivation of SN curve

Strain-Life fatigue report contents

- Summary of methodology used
- Photographs of typical fracture surfaces
- EN, SN and cyclic stress-strain curves
- Design curves (e.g. 97.7% CoS & 95% CI)
- .xml file for importing into DesignLife

Torsional Fatigue



- ▲ 50Nm rig for testing of small specimens
- ▲ Ability to test a range of R-ratios
- ▲ Generation of Shear Stress vs. Life curves including design curves
- ▲ Can be coupled up with infrared emitter rings for elevated temperature testing up to 350C
- ▲ New rig currently being built with 100Nm torque cell to accommodate stronger specimens and more ductile metals

Fatigue Crack Growth

GENERATION OF da/dN CURVES AND CALCULATION OF RHO^*

Compact tension specimen geometry

Camera system to measure crack growth

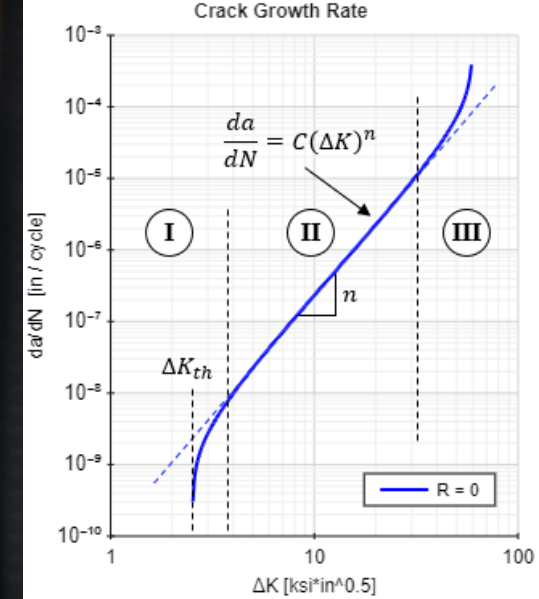
Region II (Paris region) is main area of focus

Region III (accelerated growth) gives K_c value and can be obtained by pulling the specimen to failure

Region I (threshold area) to determine K_{th} requires a very long duration test so it is expensive to try to obtain this data!

Tests can be done at different R-ratios (e.g. $R=0.1, 0.3, 0.5$)

Data supplied in a format suitable for import into WholeLife



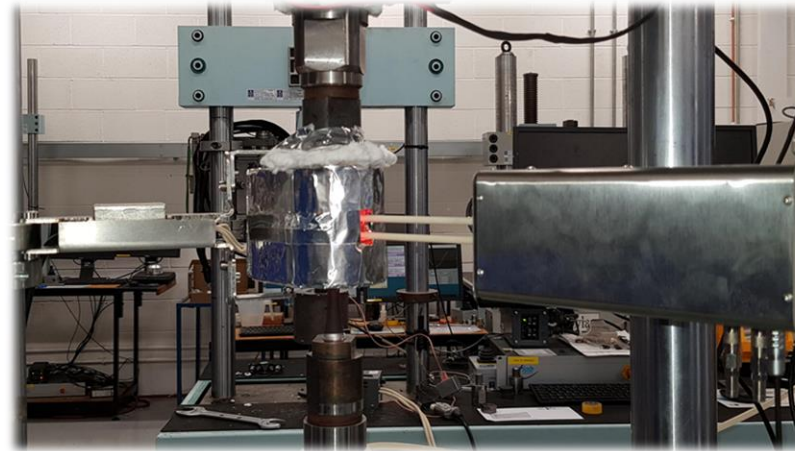
Non-Ambient Temperature Testing



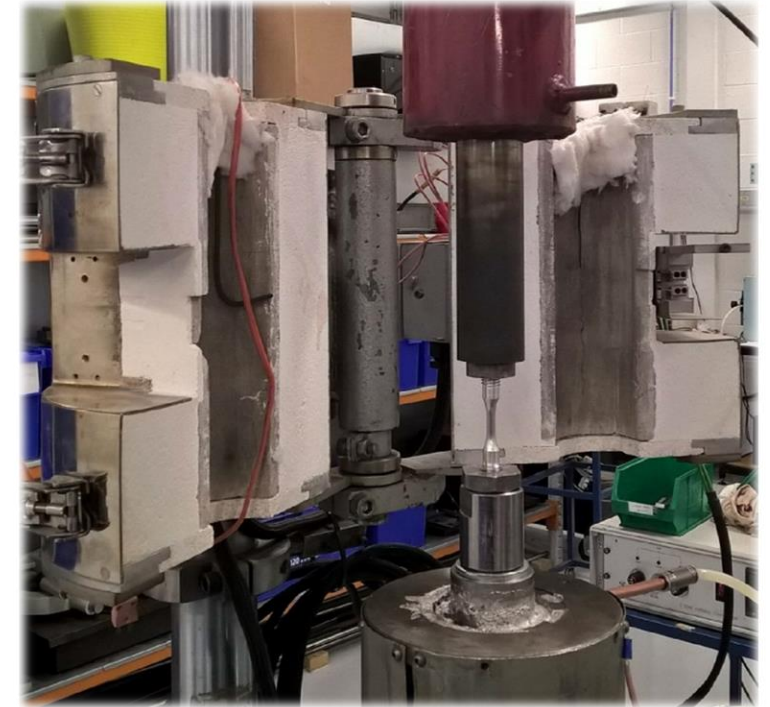
Environmental conditioning chamber with satellite test chamber:
-40C to 150C dry,
RT to 80C up to 85%rH



Induction heating



Infrared emitter rings up to 400C



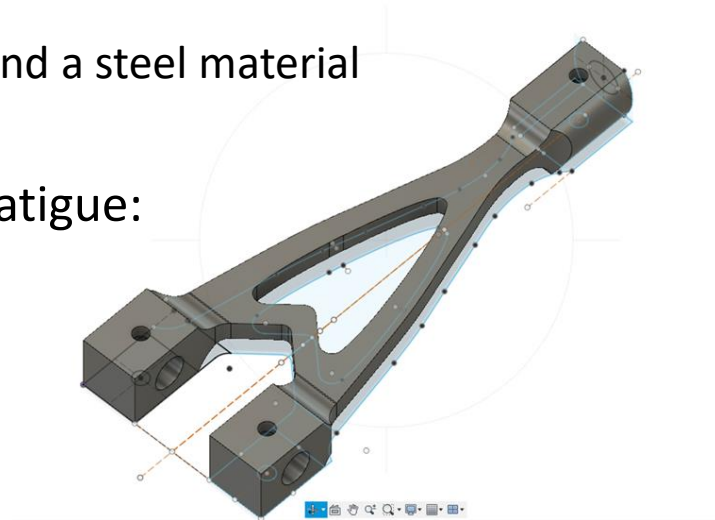
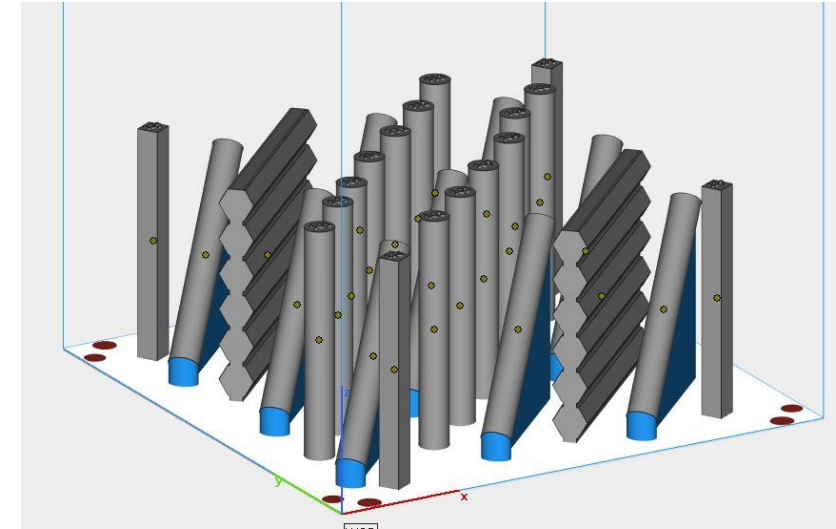
Furnaces x 3 up to 900C

Analysis of iso-thermal stress-life (SN) and strain-life (EN) curves or analysis of advanced Chaboche thermo-mechanical fatigue properties

Research Activities and Development of New Methods

Additively Manufactured Materials

- Currently part of two major AM research projects looking at fatigue behaviour in AM materials
 - NEWAM project
 - TWI collaboration
- Materials being tested include
 - Wire arc (WAAM): Ti6Al4V, an aluminium and a steel material
 - L-PBF: Ti6Al4V, IN718 and AlSi10Mg
- Studies to see how the following affect fatigue:
 - Orientation
 - Location within the build height
 - Post heat treatment
 - Powder age
- Component for DesignLife modelling validation
- All data will go into the Premium Materials Database



Light-weighting

- ▲ Testing of modern thin sheet materials for automotive structures
 - Thickness correction factors
- ▲ Testing of welded joints
 - Seam welds, Spot welds, Mixed materials
 - Use of camera systems to detect crack initiation
 - Measurement of stiffness change and correlation with crack initiation information to determine a suitable failure criteria
 - Elevated temperature testing of welded thin sheets
- ▲ Adhesives and hybrid joints
 - Working on identifying suitable testing methods alongside the Technology team's development of fatigue modelling methods





Engineering Polymers and Composite Materials

- ▲ Materials:
 - Continuous fibre composites (UD and multiaxial)
 - Unreinforced and short-fibre reinforced materials
- ▲ Testing methods
 - Stress-Life Fatigue
 - Vibration fatigue of engineering polymers
 - Thermal & moisture effects
- ▲ Data in a format to import into DesignLife composites modules

Summary

- ▲ Capabilities for uniaxial stress and strain life testing, at ambient and elevated temperatures, and subsequent fatigue data analysis
- ▲ Torsional fatigue testing at ambient and elevated temperatures, with a higher capacity rig being built
- ▲ Fatigue crack growth testing and data generation for WholeLife
- ▲ Some exciting projects on going for additively manufactured materials with data to be published in the Premium Materials Database
- ▲ Robust process in place for testing and analysis of welded joints both at ambient and elevated temperatures
- ▲ Composites and polymer testing capabilities, and the composites DesignLife module is available for customers to try

Please reach out to me if you have any questions or would like more detailed information on anything I have covered today

Thank You

Dr Michelle Hill

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