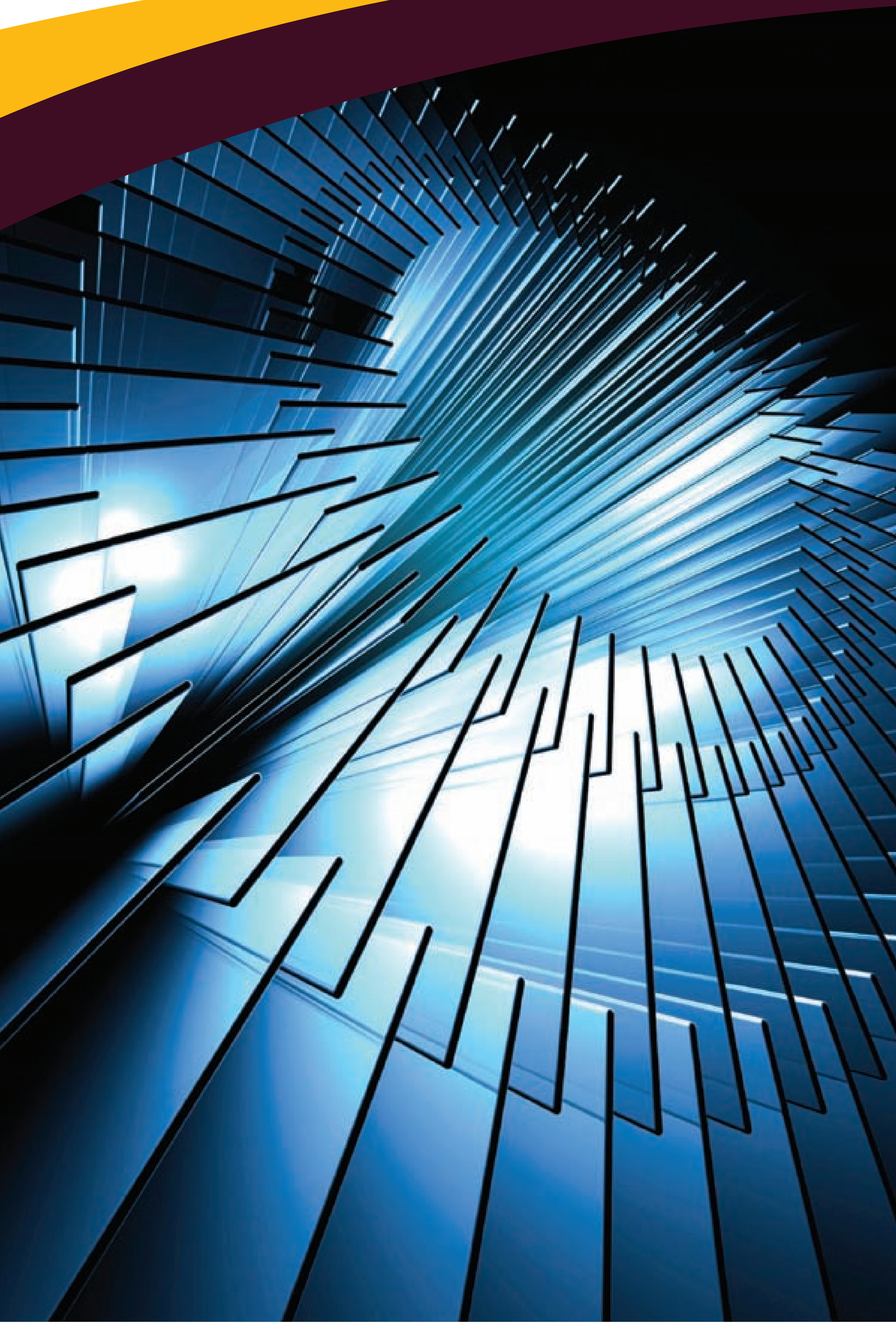
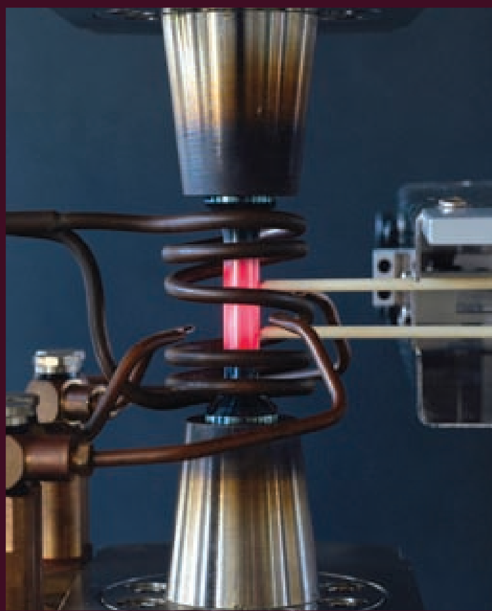
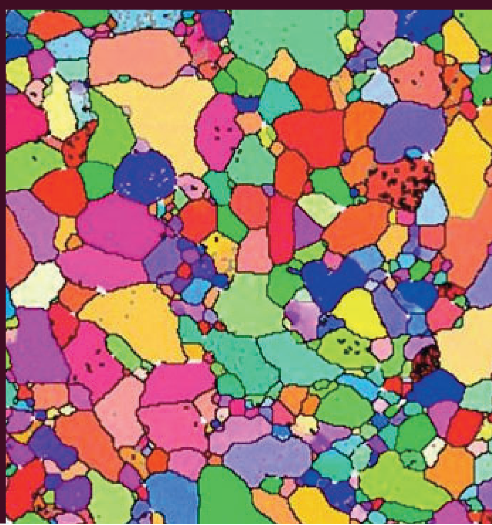
SMaRT Swansea Materials Research & Testing Ltd

The **SMaRT** route to materials solutions







The **SMaRT** route to materials solutions.

Swansea Materials Research & Testing Ltd (SMaRT) has been created to combine two long standing areas of expertise at Swansea University; world class mechanical characterisation of advanced structural materials alongside the academic interpretation of the mechanisms controlling material deformation and fracture.

SMaRT can provide support for many forms of standard mechanical property assessment, whilst at the same time addressing bespoke forms of specimen or sub-element testing where novel test development is required. In addition to generating mechanical test data, SMaRT can perform post-test failure analysis utilising optical and scanning electron microscopy, electron back scattered diffraction (EBSD) and metallographic sectioning.

We have the capacity to conduct short-term consultancies or support larger scale research programmes, all professionally managed by our skilled team of academic, research and technical staff.

For further information visit
www.smart-swansea.com

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Our Laboratory Facilities Include...

Mechanical Testing

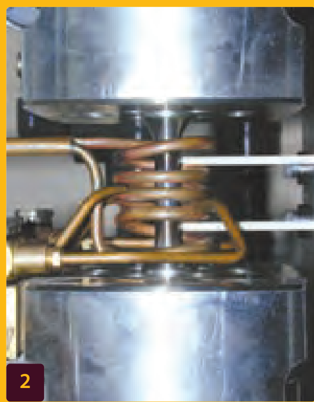
- Tension-compression
- Low and high cycle fatigue
- Fatigue crack growth
- Multi-axial tension-torsion
- Thermo-mechanical fatigue
- High precision creep
- Miniature specimen testing

Temperature

- Air conditioned labs
- Furnaces to 1400°C
- Cabinets to minus 60°C
- Induction heating
- Dry CO_2/liquid N_2 cells
- Gleeble thermo-mechanical simulation

Environment

- Laboratory air
- Partial pressure
- High Vacuum
- Gaseous Species
- Salt fog/spray
- High Temperature SO_2
- Aqueous autoclaves



1. Thermo-mechanical fatigue utilising RF induction heating
2. Strain control fatigue utilising RF induction heating
3. Controlled environment test using an aqueous autoclave
4. Aqueous environment control system

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Universal Frames

Static & Fatigue Testing

Mechanical Testing Machines

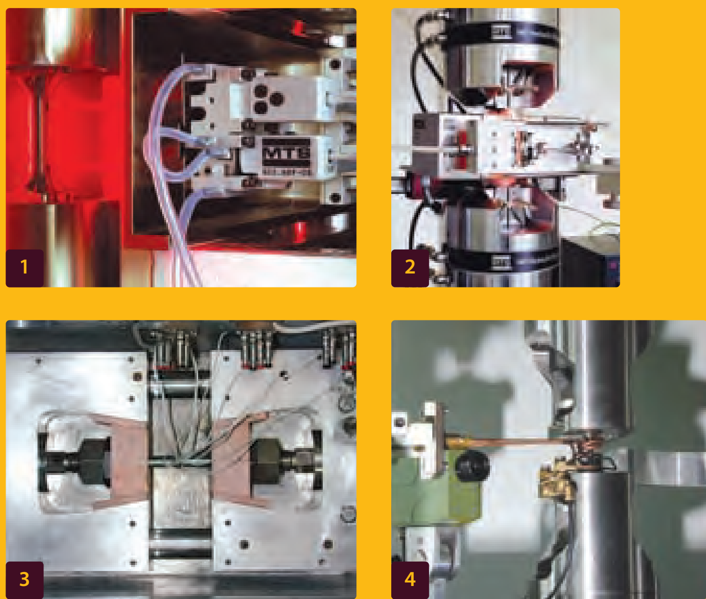
- 46 servo-hydraulic/servo electrical fatigue rigs covering:
  - Uni-axial tension-compression (up to +/-250kN dynamic, +/-400kN static)
  - Bi-axial tension-torsion (100kN tension/400 Nm torsion)
  - Thermo-mechanical fatigue (TMF)
  - Frequencies: from static/dwell loading up to 100Hz
  - Four electro-resonance machines for High Cycle Fatigue (HCF) assessments up to 200Hz

All test frames and supporting test devices are annually calibrated to UKAS standards.

Environmental Control

In conjunction with the above machines, the following hardware is available to enable testing in a variety of controlled environments:

- Conventional radiant furnaces/ovens: minus 60°C to 1400°C
- Vacuum chambers: controlled partial pressures or hard vacuum to 10^{-6} mbar
- Gaseous atmospheres (hydrogen, argon etc)
- Salt fog cabinet, corrosion fatigue conditions
- Aqueous baths
- Autoclaves capable of 2 bar pressure, 120°C maximum temperature with control of oxygen and chlorides to parts per million (ppm)
- Hot sulphidation chambers



1. High temperature strain controlled fatigue
2. High temperature test assembly utilising hydraulic wedge gripping and high temperature extensometry
3. Gleeble load train employed for microstructural weld evaluation or resistance bonding research
4. Thermo-mechanical fatigue with pyrometer temperature control

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Universal Frames

Static & Fatigue Testing

Procedures & Monitoring

Monotonic properties, low and high cycle fatigue (LCF/HCF) and fatigue crack growth can all be evaluated employing in-house procedures based upon British and International standards. Methods of monitoring fatigue deformation and crack development include:

- Pulsed DC and AC potential drop systems
- Automated optical records
- Replication media
- Bulk strain accumulation (extensometry) and localized plasticity (strain gauges)

Support Services

SMaRT can accommodate a wide range of pre and post test support services, these include:

- Workshops experienced in CNC machining of test specimens from advanced alloys and composites
- State of the art scanning electron and optical microscopy
- Electron Dispersive X-ray (EDX) chemical characterization
- Electron Back Scattered Diffraction (EBSD) microtextural analysis equipment
- Computer software providing full 3D elastic-plastic modeling and stress analysis
- Digital image correlation

1

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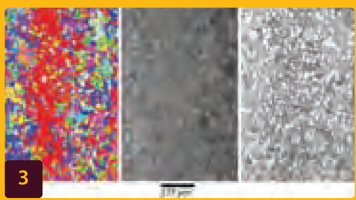

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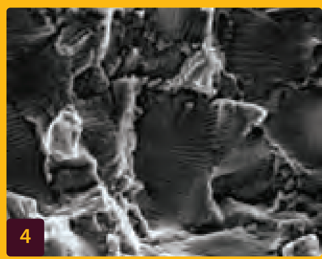

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1. Test specimens machined from advanced alloys
2. Scanning Electron Microscope (SEM)
3. Electron Back Scattered Diffraction (EBSD) map / polarised light / conventional microscopy images of macrozone Ti 6/4 microstructure
4. Fatigue striations in a metallic material

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Creep & Stress Rupture Testing

Testing Machines

- 24 constant-stress tensile machines for testing of metals and alloys at temperatures up to 1000°C
- 50 constant-load tensile machines for testing of metals and alloys at temperatures up to 1100°C
- 4 constant-load tensile machines for testing of ceramics and ceramic composites to 1400°C
- 2 constant-load tensile machines for testing metals and alloys under very low stress conditions at temperatures up to 800°C
- 4 servo-hydraulic machines for creep testing under tension compression/torsion conditions to 900°C
- 8 miniature disc creep test machines for testing of metals and alloys at temperatures up to 800°C

Environmental Control

Although most creep studies are conducted in air, facilities are available for vacuum/argon testing of metals and alloys to 800°C and of ceramics and ceramic composites to 1400°C.

Procedures & Monitoring

Creep & Stress Rupture Tests are carried out employing in-house procedures based upon British & International standards. All creep machines are equipped with high-precision extensometers capable of monitoring changes in specimen gauge length to 1μm using pairs of differential-capacitance transducers linked to data recording systems.

1. Constant Stress Creep Machines



Small Disc Punch Testing

Specimen Extraction

"Scoop" extractor to minimise material volume
Machined discs 9mm diameter x 1mm thickness.

Test Facilities

- Eight rigs suitable for assessments up to 800°C
- Planned upgrades for two rigs to > 1200°C
- Conventional small disc punch testing
- Constitutive & fracture toughness testing also available

Previous studies

- Power generation steels
- Aerospace alloys
- Stress-rupture evaluation
- Remnant life assessments
- Creep curve analysis
- Fundamental creep mechanisms
- UTS & K1C on similar disc specimens

Contacts

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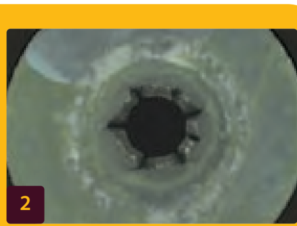

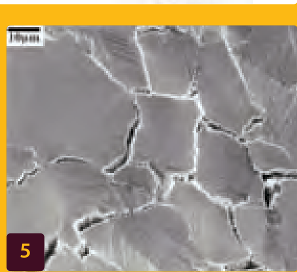

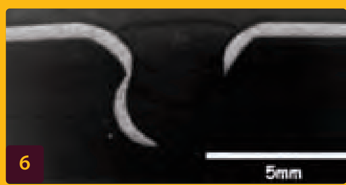

1. Cracking as the result of creep
2. Fracture of a disc specimen
3. An example of disc specimen produced from a 'scoop' sample
4. Complete specimen rupture
5. Creep cavitation on the surface of a Small Punch creep specimen
6. Post test cross-section of a Small Punch creep disc specimen

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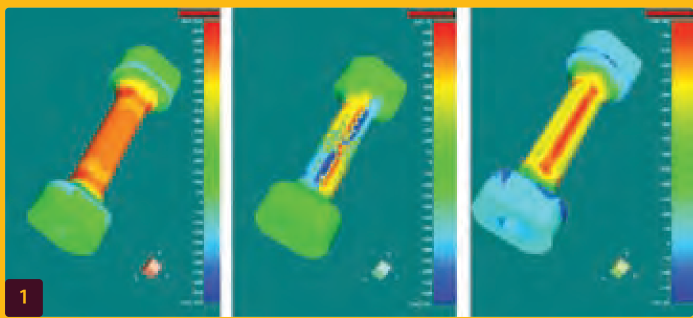
Additional Research & Testing Facilities

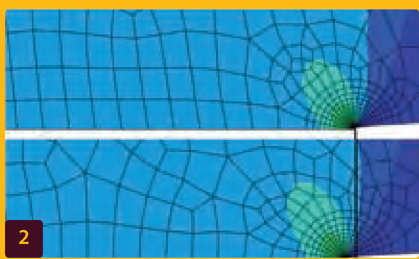
Research Facilities

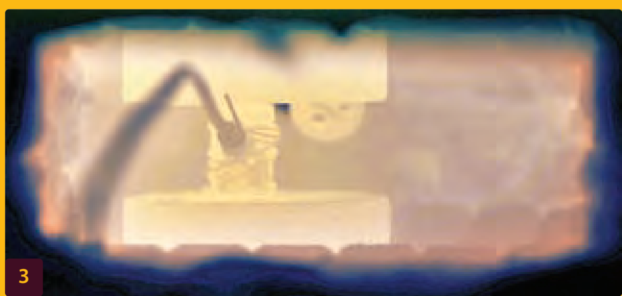
- 2 servo-hydraulic machines for compression flow stress evaluation under low (10^{-4} sec^{-1}) and high (50 sec^{-1}) rate high temperature conditions to 1250°C, with facilities for testing under vacuum
- Gleeble thermo-mechanical simulators for TMF, welding and bonding research in air, inert gas & vacuum conditions
- Vickers macro/micro hardness testing machines
- Impact testing machines
- A comprehensive metallography suite for microstructural analysis pre & post test.

Finite Element Modelling

Finite element modelling capability is available amongst the SMaRT team to support stress analysis of specimen and sub-element geomtries plus predictions of mechanical performance. Models to describe complex creep-fatigue interactions have been developed to predict cyclic deformation and crack propagation based on laboratory generated constitutive behaviour. Various commercial or in-house codes are employed.







1. Finite Element (FE) Modelling
2. Abaqus 2D crack propagation model
3. Forging Test at 1200°C

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