MTS Thermomechanical Fatigue (TMF) Testing Solutions

A flexible system for cycling materials at varying strains and temperatures

- Designed to streamline repeatable test setup
- Easy access to the specimen for straightforward specimen changes
- Precise and repeatable positioning of coil and air vents relative to specimen
- Integrated control of the load frame, heating, and cooling using MTS TestSuite™ software
- Predefined test templates compliant with ASTM E2368, ISO 12111 and the European Validated Code-of-Practice for Strain-Controlled Thermomechanical Fatigue Testing

Thermomechanical Fatigue (TMF) tests characterize the response of materials to a combination of cyclic mechanical and thermal loading. These tests require uniform application, simultaneous variation, and independent control of temperature and strain.

The MTS Thermomechanical Fatigue (TMF) Solution provides a comprehensive, packaged solution to address complexities of TMF testing. This solution applies thermal cycles to metallic, magnetically susceptible specimens using a combination of induction heating and air cooling. The independent controlled mechanical and thermal cycle allow thermomechanical fatigue tests to be performed with any temperature mechanical strain phasing relationship.

The MTS TMF Testing Solution reduces set-up times, simplifies specimen changes and increases the precision of the test data. It is specifically engineered to perform highly accurate and repeatable strain-controlled TMF testing at specimen temperatures up to 1200°C. The solution includes extremely versatile software that can read temperature and total strains measured by an extensometer, as well as calculate and control mechanical strain in real-time.

System Configuration

The MTS Thermomechanical Fatigue (TMF) Testing Solution is compatible with the MTS Landmark® Servohydraulic Test System and includes:

- RF generator and temperature controller
- RF remote oscillator
- Induction coil for round specimen
- Mounting brackets and coil positioner
- External air-cooling arm
- MTS TestSuite™ MP Software
- Standard-compliant software templates
- MTS TestSuite Software TMF module

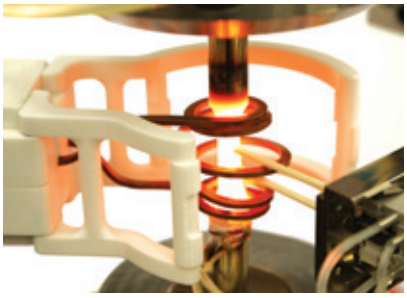
RF GENERATOR AND TEMPERATURE CONTROL CABINET

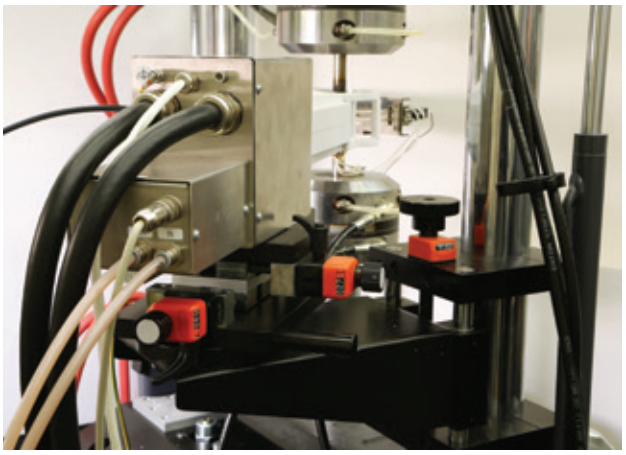
- Integrated with MTS FlexTest® controller
- 10 kW RF Generator with a frequency range from 50 to 200 kHz at 10 kVA
- Dual output temperature controller
- Type K control thermocouple, type R optional
- Monitors up to 16 thermocouples
- Cooling water flow and over-temperature interlocks

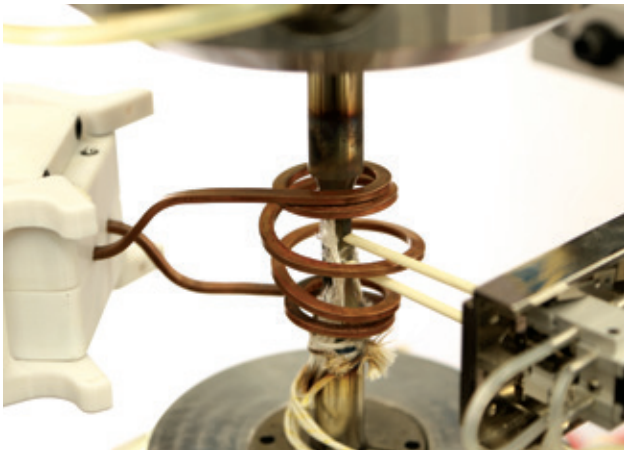
Designed for Repeatable Testing

FLEXIBLE AND CONFIGURABLE AIR COOLING ARM

- Each air vent can be set in five different positions
- Adjustable air flow rate
- Air cooling jets fold back and out of the way to gain access to the specimen
- Arms snap back into original position again and again improving the repeatability of the test set-up







REPEATABLE POSITIONING

- Subassembly containing the induction coil, air cooling system, and RF Remote Oscillator sit on a x, y, z positioning system that allows 50 mm (2 in) of travel along each axis
- Quick release slide allows the coil to be easily moved away for specimen insertion and removal then painlessly returned to its original position

INDUCTION COIL

- Coated with electrically insulating material that reduces risk of electric shock
- Manufactured using a 3D-printed mandrel to ensure each coil has exactly the same geometry

Software Features

The MTS TestSuite™ TMF module includes predefined test templates that were developed according to ASTM E2368, ISO 12111, and European Validated Code-of-Practice (CoP). Existing templates can easily be modified to conform to other test procedures and requirements by adjusting test logic and creating needed variables and calculations. The templates support employing either time-based or temperature-based thermal strain compensation, and running test with or without commanding active cooling. The test templates can also be customized to run other types of TMF tests, such as load controlled TMF, superimposed HCF/TMF and Creep TMF.

Test Setup

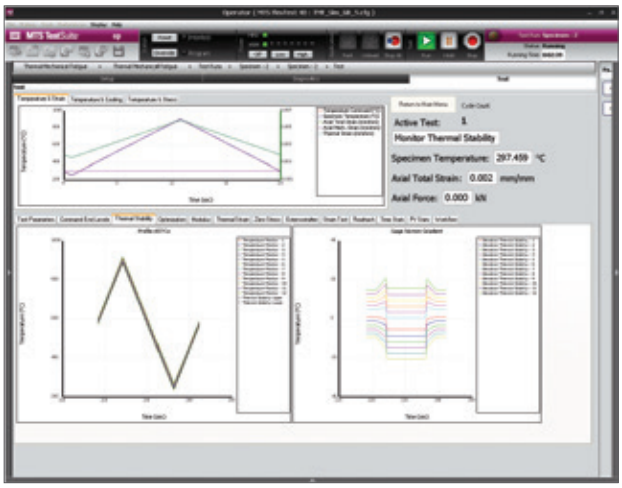
The software provides an integrated approach to run all TMF test setups in one test program. The test setup begins with test parameter entry, allowing the operator to enter the test information, define and input test waveform including the temperature/mechanical strain phasing and define data acquisition parameters. The test parameters are automatically exported and stored in the computer hard drive and can be reused for future TMF tests.

Running a Test

The MTS TestSuite TMF software includes real-time monitoring of the mechanical strain and temp
that waveforms are repeated throu

Reporting and Analysis

When your test is complete, the software can create a report against a pre-defined template. Reports can include all input information and measurements, and they can be amended with user-entered calculations based on reported values. The optional Fatigue Analyzer provides additional insight into your post-test data, including detailed temperature-versus-cycles analysis.



The Runtime View of thermal stability at batch level offers simple validation that the temperature gradient has been achieved

Integrated TMF tests include running:

- Thermal profile test and generating temperature profile report
- Modulus test to measure elastic modulus and generating modulus report
- Thermal test to measure thermal strain and calculating thermal expansion coefficients to be used for temperature-based thermal strain compensation
- Zero stress test in either time-based or temperature-based thermal strain compensation to verify the test setup

TMF Solution Overview

Specifications

Maximum Specimen Temperature	1200°C (2192°F)
Typical Heating Rate*	10°C/s (18°F/s)
Typical Cooling Rate*	5°C/s (9°F/s)
Standard Coil Geometry *Custom coils available upon request*	» 50 mm (2 in) tall coil with 5 tapered spiral turns » Includes internal water cooling
Standard Specimen Types	Round Hollow *Option for internal cooling of hollow specimens***
Standard Specimen Geometry	Minimum Length: 125 mm (5 in) Diameter: 6 to 12 mm (0.25 to 0.5 in)
RF Generator Power	10 kW
RF Generator Frequency Range	50 to 200 kHz at 10 kVA
Thermocouple Type	K (R optional)
Temperature Control and Interlocks	Two temperature controllers with safety interlocking » One provides control » One is for over-temperature
Number of Temperature Monitoring Channels	Up to 16
Coil Adjustment: Maximum Travel of x, y, z Positioner	50 mm (2 in)
Certification	CE/NRTL

**Dependent on specimen material, specimen geometry, and required temperature range.*

***Requires modified grips.*

Learn more today

Contact us for more information about how MTS can help you optimize your high-temperature materials testing capabilities.

MTS Systems Corporation

14000 Technology Drive
Eden Prairie, MN 55344-2290 USA

Telephone: 1.952.937.4000
Toll Free: 1.800.328.2255

E-mail: info@mts.com
www.mts.com

ISO 9001 Certified QMS

100-334-644b TMFsolutions • Printed in U.S.A.• 01/24