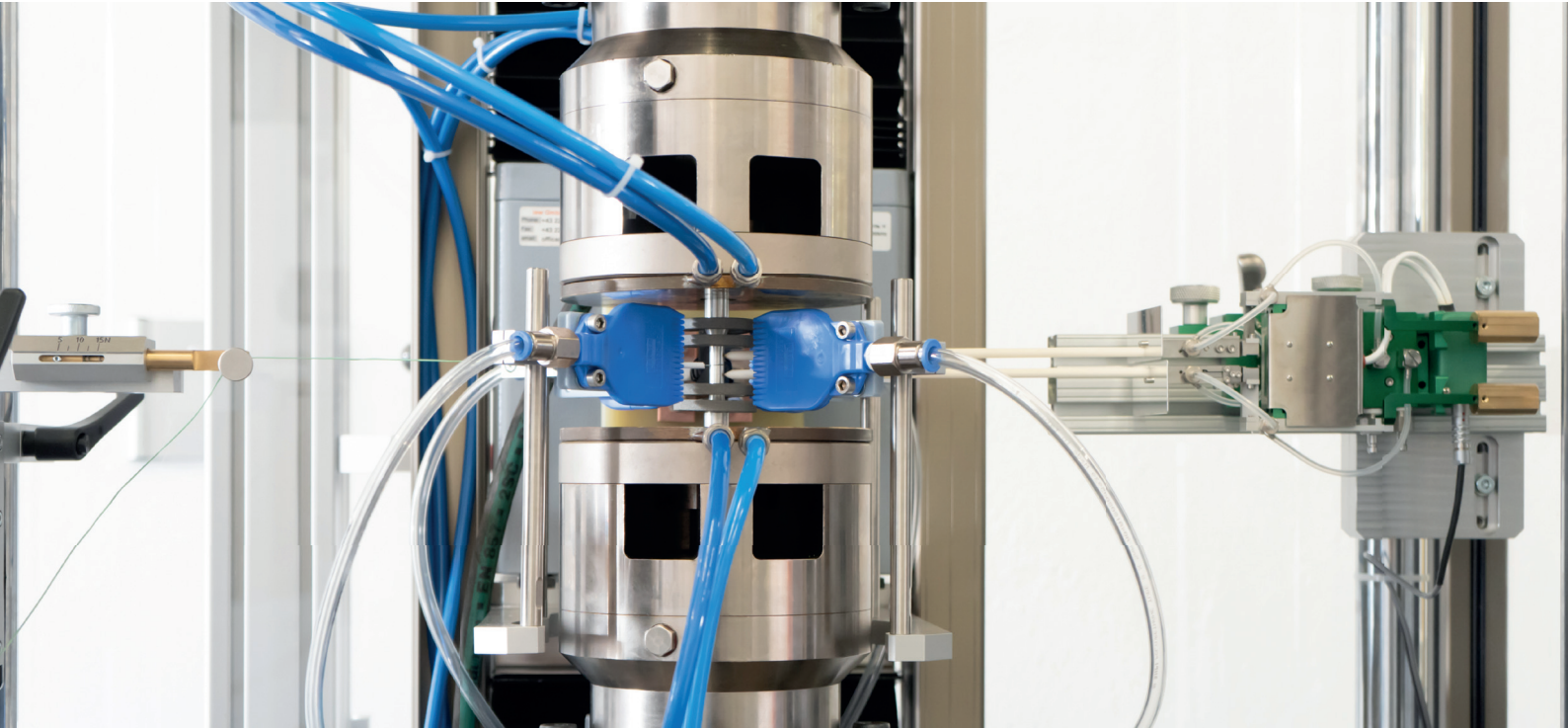
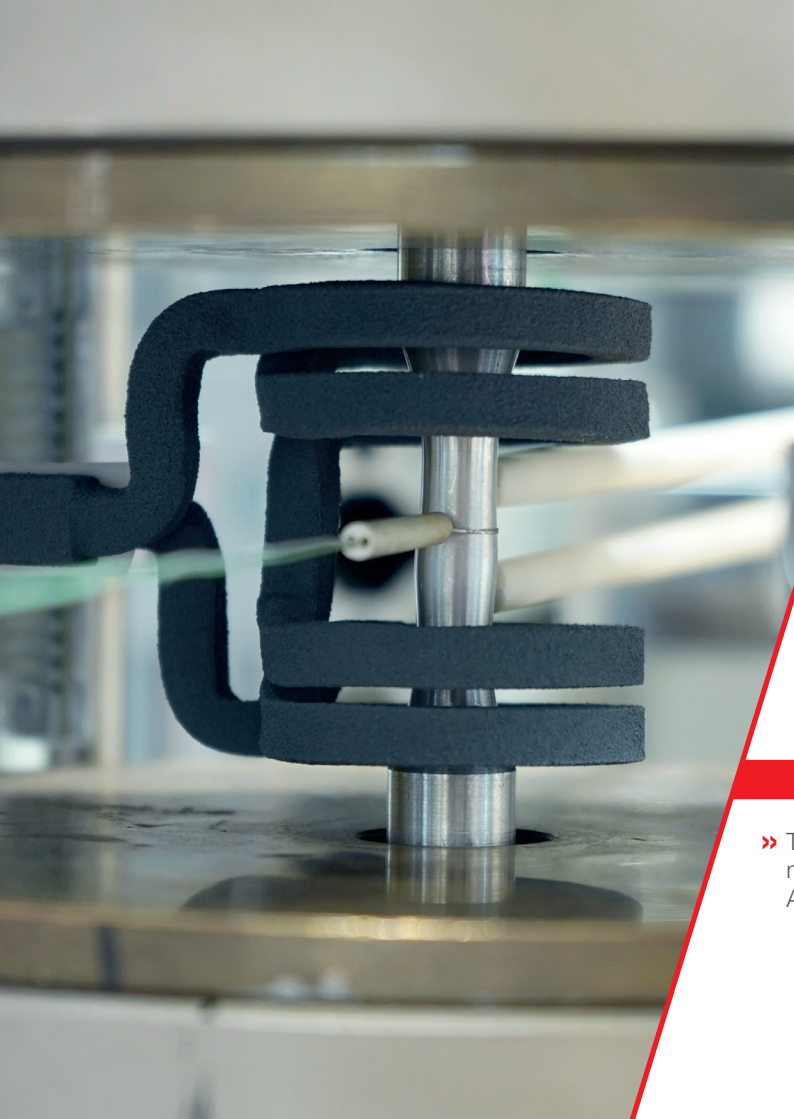


# Thermo-Mechanical Fatigue Testing

A knowledge-based expert system for solving complex test requirements





## A knowledge-based expert system for solving complex test requirements

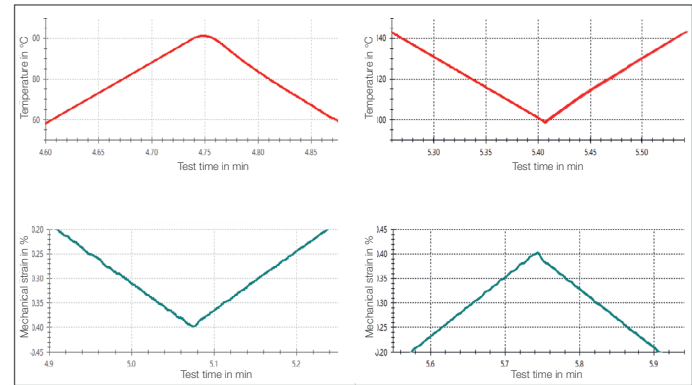
For reliable assumptions on fatigue life and for optimal and safe design of thermo-mechanically loaded components, precise characteristic values of the deformation behavior of the components used are essential. This test system guarantees easy handling and repeatable test results, even with complex test requirements.

### BENEFIT: RELIABLE TEST RESULTS

- » The testing system for thermo-mechanical fatigue testing meets all requirements of the European Code of Practice (CoP), ASTM E 2368 and ISO 12111.

## Workflow oriented operator assistance through automated testing with testXpert

- Reliably determining material behavior under cyclic thermal and mechanical load is an elaborate test task, which can, however, be made significantly easier with this knowledge-based expert system.
- Depending on the damage mechanisms to be tested, temperature phasing and mechanical strain range can be selected accordingly.
- Testing system operation is designed to be purely intuitive. The user is guided through the various steps of a test, from preparing and running the test to analyzing results (no separate calculations or external software support required).



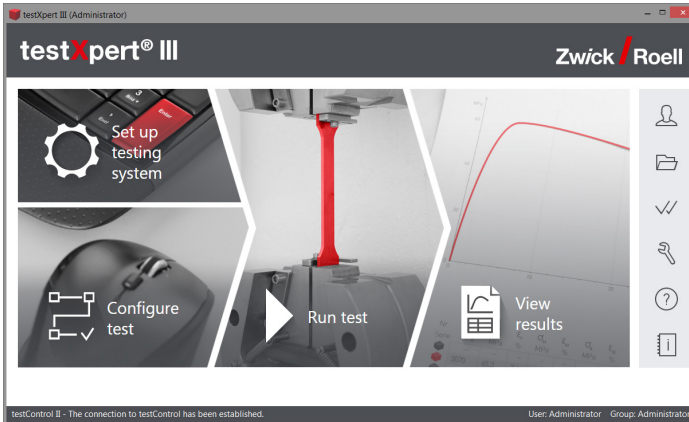
Precise control of the temperature and mechanical strain



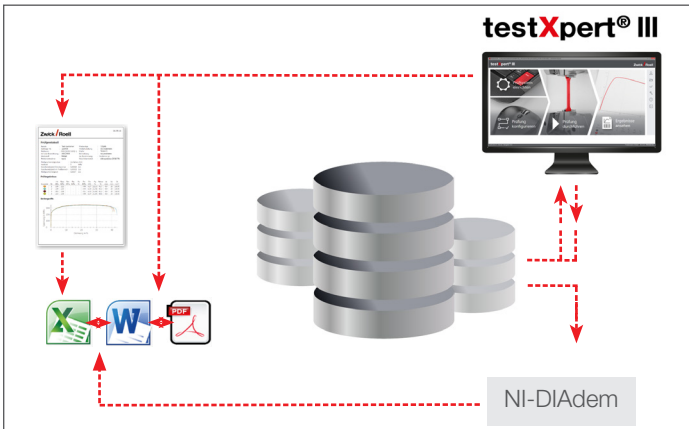
Chronological sequences of temperature, mechanical strain and standard force - IP (orange), OP (blue), CD (red), CCD (green)

## Tailored TMF control system for real-time acquisition of the measurement data

- Real-time acquisition and processing of temperature, force and strain for reliable test results
- Determination and specification of the mechanical set value sequence for force and strain control and the thermal set value sequence for the automatically controlled heating and cooling cycles
- Precise control and synchronization of the mechanical and thermal cycles
- Real-time display of the test sequence for optimal monitoring of the test



Intelligent setup assistant



Flexible export interface

## Easy test configuration and traceability

- The intelligent setup assistant shows the user which test parameters must be configured and automatically checks all entries for plausibility.
- Freely selectable heating ramps, max. and min. temperatures, hold times and number of pre-cycles; separate parameters for heating and cooling and various phase shifts
- Storage of test parameters for future tests
- Recording of testing system and system settings so you always have the answer to the question: "Who does what, when, why and who is responsible?"

## Flexible and convenient evaluation options

- Storage of all test cycles, with clear evaluation options and flexible export interface in NI TDMS file format for easy further use, e.g. in Excel
- Complete recording of up to 500 cycles with the software and the individual or group presentation of the cycles is possible.
- Additional verification of all test data in secure mode
- Easy export of data to all common evaluation/analysis platforms and comparison of cyclic stress and strain curves for individual test types.

## Precise control with patented electromechanical testing machine

- For testing with low frequency load cycles, the patented Kappa SS-CF electromechanical testing machine has proven itself time and again, over the years.
- The backlash-free zero crossing during cyclic tensile and compression loading allows for very precise control of the test force and test speed.
- With the precise crosshead guidance and adjustable alignment fixture, standard-compliant axial alignment requirement to ISO 23788 and NADCAP can be ensured.
- Excellent control behavior for force, stress and strain are possible with the high resolution motor encoder, the high resolution force channel and the corresponding extensometer.

**BENEFIT: PATENTED AND ZERO BACKLASH**

- » Development cooperation with **Karlsruhe Institute of Technology (KIT)** and partnership with specialist in induction heating systems and their controls **Induktive Erwärmanungsanlagen GmbH (iew)**





## Flexible heating and cooling rates

The induction heating system with an individually adjustable heating capacity allows testing of various materials with different electrical conductivity. Specimen-specific inductors ensure the optimal temperature distribution.

Proportional pressure control valves with four symmetrically arranged flat spray nozzles provide precise control of the air flow. The position of the cooling nozzles is adjustable and, for future tests, reproducible.

### BENEFIT: ACCURACY

- » In accordance with Code of Practice (CoP), the temperature deviation from the specified set value in the specimen measuring distance is  $< 10\text{K}$  or  $< \pm 2\%$  of the temperature difference. Depending on specimen shape and material, heating rates up to  $25\text{ K/s}$  are possible.

## Easy handling and standard-compliant temperatures

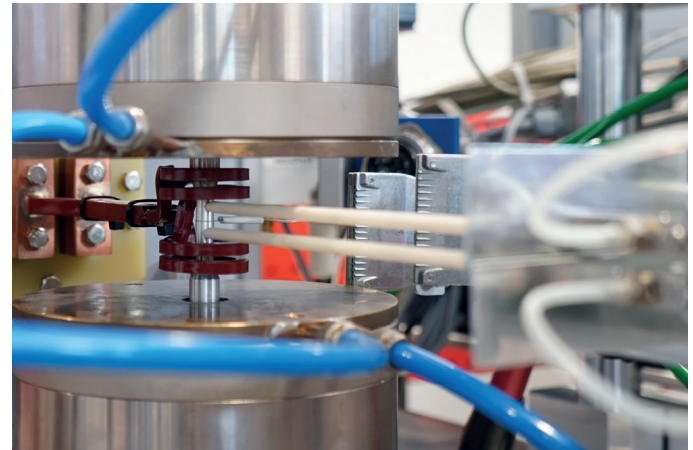
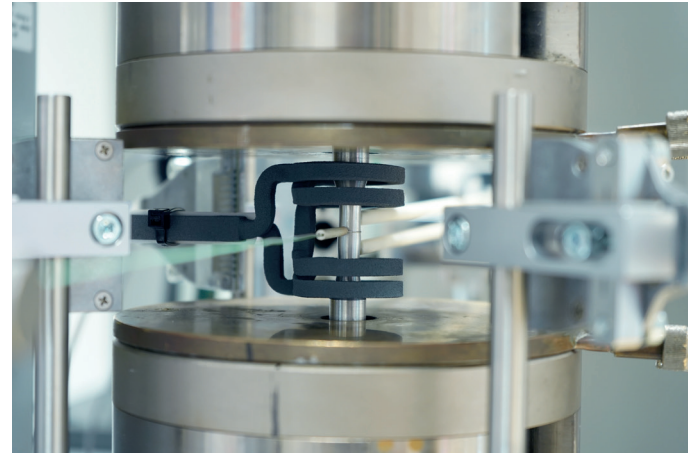
- Ribbon thermocouples in the center of the specimen, attached with adjustable spring pre-tensioning for dependable contact pressure, make temperature control easy and reliable
  - $\leq 850^{\circ}\text{C}$ : Type K
  - $> 850^{\circ}\text{C}$ : Type S
- The transparent safety enclosure ensures optimal operator protection as well as stable environmental conditions and an unhindered view of the specimen during the test.

## Secure hold with the appropriate specimen grips

- Hydraulic grips suitable for tensile/compression alternating load and backlash-free through zero forced operation or even fully reversed operation
- Water cooling for fast temperature stabilization along the specimen and for direct heat outflow from the specimen end.

## Reliable strain measurement

- Contacting extensometer with water cooling and silicon carbide ceramic sensors for tests up to  $1.600^{\circ}\text{C}$
- Specially designed to meet the strict requirements for strain-controlled tests to ISO 6892 and also the accuracy requirements of ASTM E83 class B2 and ISO 9513 in accuracy class 0.5
- Automatic setting of the gauge length between individual tests and controllable contact force for repeatable positioning with the same force on subsequent specimens.





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ZwickRoell Testing Systems GmbH  
 [www.zwickroell.com](http://www.zwickroell.com)

 Flugplatzstr. 5  
A-8280 Fürstenfeld

 +43 3382 54060-0  
 [info.at@zwickroell.com](mailto:info.at@zwickroell.com)

[www.zwickroell.com](http://www.zwickroell.com)

