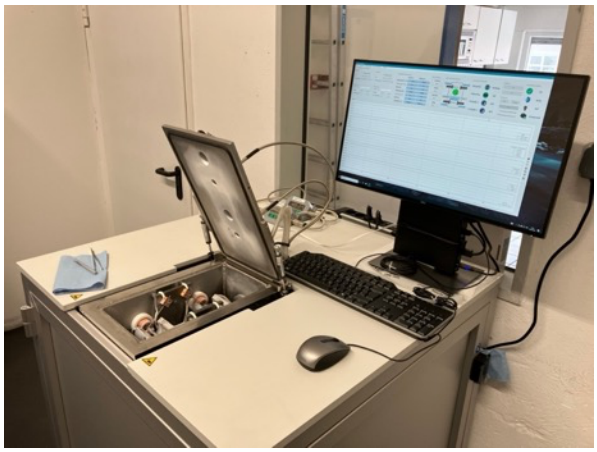
Spektrum Engineering GmbH
Hauptstraße 1 • 63871 Heinrichsthal • Germany

Industrie 4.0 = IoT
siincos.de

Mail: info@spektrum-engineering.de
Web: www.spektrum-engineering.de

QM on Ceramic Parts



Ensuring and controlling the quality of industrially manufactured products, particularly ceramic components, is a fundamental pillar of production. The guiding principle here is "better safe than sorry," especially as it often aligns with customer demands. Multiple factors, from shaping to sintering, must be simultaneously monitored to guarantee product quality.

It is crucial to conduct various chemical and physical tests on technical ceramics to oversee each production step and evaluate the status before moving on to the next, more expensive manufacturing phase. This includes both non-destructive and destructive testing methods on the final component, such as:

- **Non-destructive testing methods:**
  - Resonance frequency measurement
  - Microscopy
- **Destructive testing methods:**
  - Hardness testing
  - Strength testing

Additionally, monitoring incoming materials is equally important. This involves knowing and overseeing the critical quality parameters of the powders, binders, and process conditions used.

A thorough understanding of the processes is advantageous for accurately assessing the final quality of the finished workpiece. Only a complete examination of the process, considering all components and their interactions, provides comprehensive insight into the production quality.

Spektrum Engineering GmbH
Hauptstraße 1 • 63871 Heinrichsthal • Germany

Industrie 4.0 = IoT
siincos.de

Mail: info@spektrum-engineering.de
Web: www.spektrum-engineering.de

What are the Standards for Industrial Quality Control?

Industrial quality assurance is generally guided by established national and international standards or methodologies that are widely recognized and applied. These include:

- **ISO 9001:** Provides a framework for quality management systems that ensure products meet customer and regulatory requirements.
- **Lean Six Sigma:** A method that relies on a collaborative team effort to improve performance by systematically removing waste and reducing variation.
- **GMP (Good Manufacturing Practice):** Ensures that products are consistently produced and controlled according to quality standards.

These frameworks offer extensive guidance on managing and improving both manual and automated processes of high complexity. By breaking down processes into their individual steps, one can define a secure process environment and workflow. This approach allows for the early detection of errors and continuous improvement of the manufacturing process (KVP = Continuous Improvement Process).

Simultaneously, the quality characteristics of each process step must be defined, and the necessary measuring instruments and their threshold values established. This enables immediate intervention in the process in the event of deviations.

What are the Production Influencing Factors and Their Impact on the Quality Control of Ceramic Components?

Due to the complexity and cost, expectations for ceramic finished products are very high. Monitoring the raw materials used and their preparation into powder form is of significant importance. This involves:

- **Powder Preparation:**
    - Milling
    - Mixing
    - Spray drying
    - Addition of additives, such as binders
- **Forming Techniques:**
    - Casting
    - Pressing
    - Extruding
    - Mechanical processing

The final step typically involves sintering, where the focus is on generating a defined microstructure depending on temperature and atmosphere. This process results in end products with specific characteristics, such as:

- **Shape**
- **Strength under various conditions (compression, shear, bending, etc.)**
- **Porosity**
- **Grain size**
- **Grain boundary characteristics**
- **Purity (concerning contaminants or foreign components in the compound)**
- **Chemical resistance**
- **Electrical properties**

Hot Resistance Measurement for Quality Control of Ceramic Components

Our laboratory has specialized in measuring the electrical properties of ceramics at different temperatures. We measure the hot resistance and surface temperature of a defined sample (typically a core-drilled rod with a diameter of 8 to 10 mm extracted from the ceramic block) under increasing electrical power. The procedure is as follows:

- **Sample Preparation:**
  - Insert the sample into the apparatus.
  - Contact the sample between two electrodes.
  - Evacuate the apparatus to create an oxidation-free environment.
- **Measurement Process:**
  - Gradually apply increasing voltage to the sample.
  - Heat the sample to incandescence by increasing voltage.

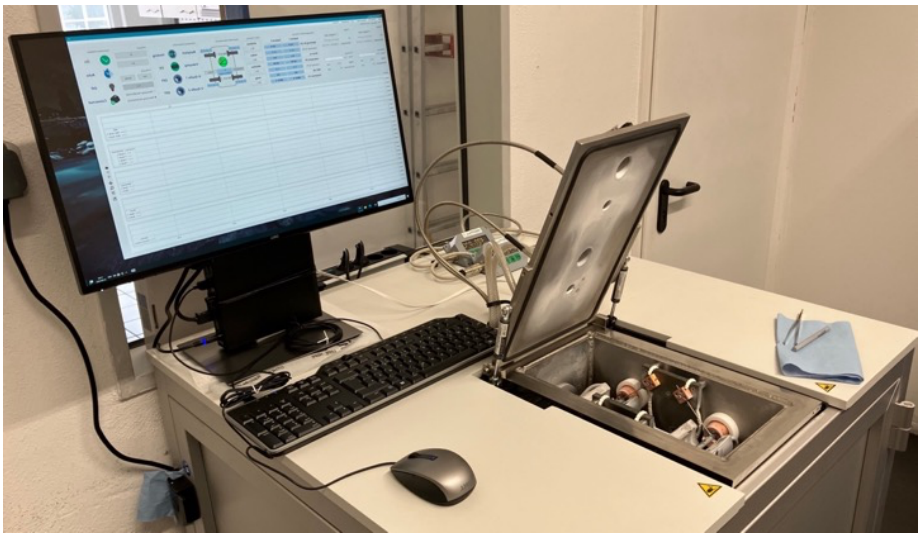
During this process, we continuously measure the voltage drop across the sample's ends and calculate the resistance as a function of temperature using the measured current and applied voltage. The laboratory equipment generates a report after the measurement, including a graph of all process parameters. If all values fall within a defined tolerance curve, the material is approved for further production. Otherwise, the material is rejected and recycled.

Spektrum Engineering GmbH
Hauptstraße 1 • 63871 Heinrichsthal • Germany

Industrie 4.0 = IoT
siincos.de

Mail: info@spektrum-engineering.de
Web: www.spektrum-engineering.de

Our Systems key features



- Measuring ceramic rods resistivity between 400 … 6000 moc
- Working pressure between 0.04 and 0.001 mbar
- Two test benches for measuring two rods in parallel
- DC current measuring for clearer results
- Supports ceramic rods:
  - Length: 110 mm
  - Diameter: 8 mm

- Automated measuring procedure
  - Insert rods
  - Press start
  - Wait for result

- Customizable measurement procedure
  - Up to 2000°C
  - Up to 20 kW per rod
  - 3 … 30 minutes measuring

- Integrated Lab Software “ReBench App”
  - Automated testing procedure
  - Warning & Alarm management
  - Database System to track all measurements
  - AI powered real-time result assessment
  - Modern UI for Linux, macOS and Windows Computers
  - Multi language support

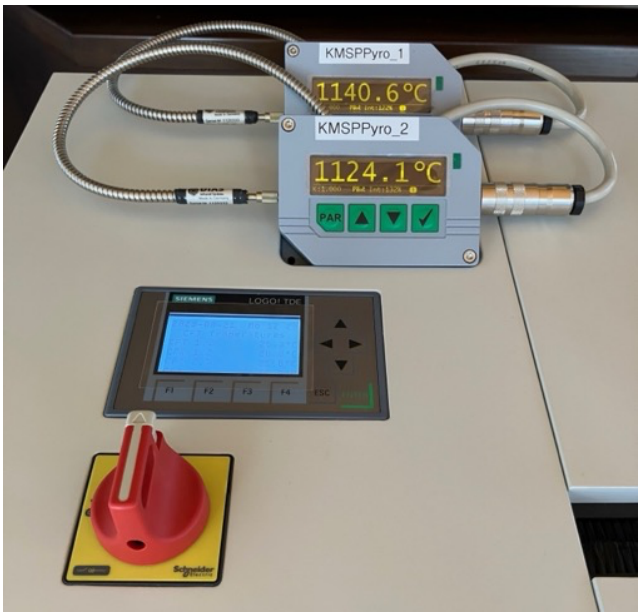
- System is built on wheels for comfortable moving and rigging
- Fits through a standard door
- Works with 400V AC / 32A – CEE plug (3P-N-PE)
- Water cooled

Spektrum Engineering GmbH
Hauptstraße 1 • 63871 Heinrichsthal • Germany

Industrie 4.0 = IoT
siincos.de

Mail: info@spektrum-engineering.de
Web: www.spektrum-engineering.de

Pyrometers for integrated temperature measurement up to 2000°C



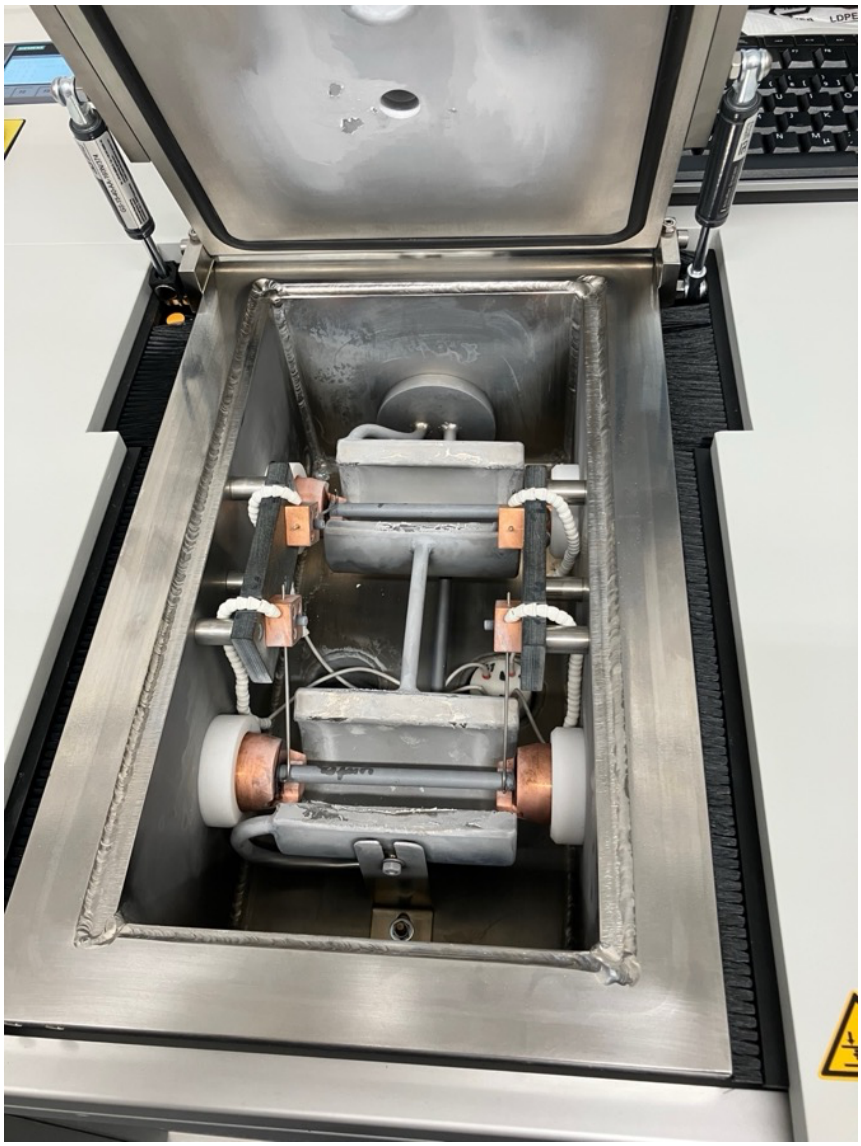
Sight glass to visually monitor the measuring process

Spektrum Engineering GmbH
Hauptstraße 1 • 63871 Heinrichsthal • Germany

Industrie 4.0 = IoT
siincos.de

Mail: info@spektrum-engineering.de
Web: www.spektrum-engineering.de

Easy access to the vacuum chamber for comfortable inserting and removing the ceramic rods

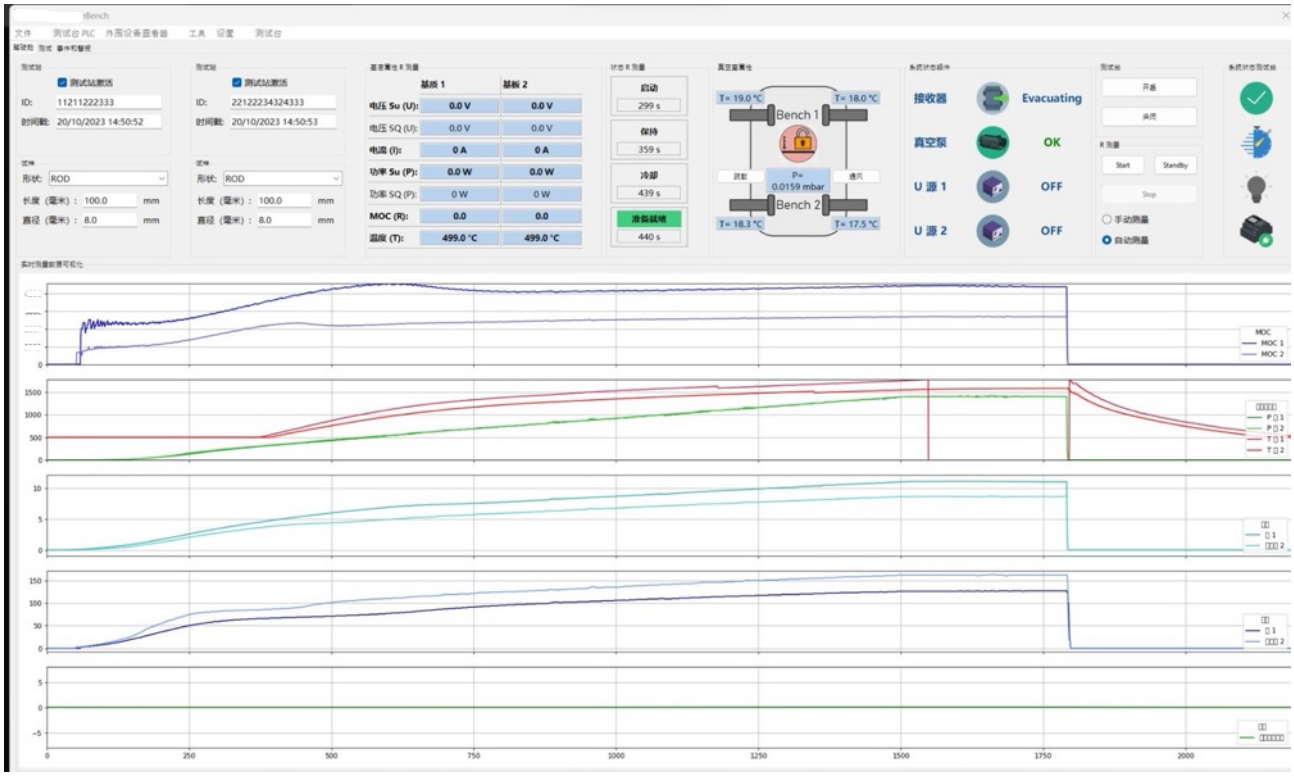


Spektrum Engineering GmbH
Hauptstraße 1 • 63871 Heinrichsthal • Germany

Industrie 4.0 = IoT
siincos.de

Mail: info@spektrum-engineering.de
Web: www.spektrum-engineering.de

System is fully controlled and managed using the integrated “ReBench App”



Multi language support and integrated alarm management