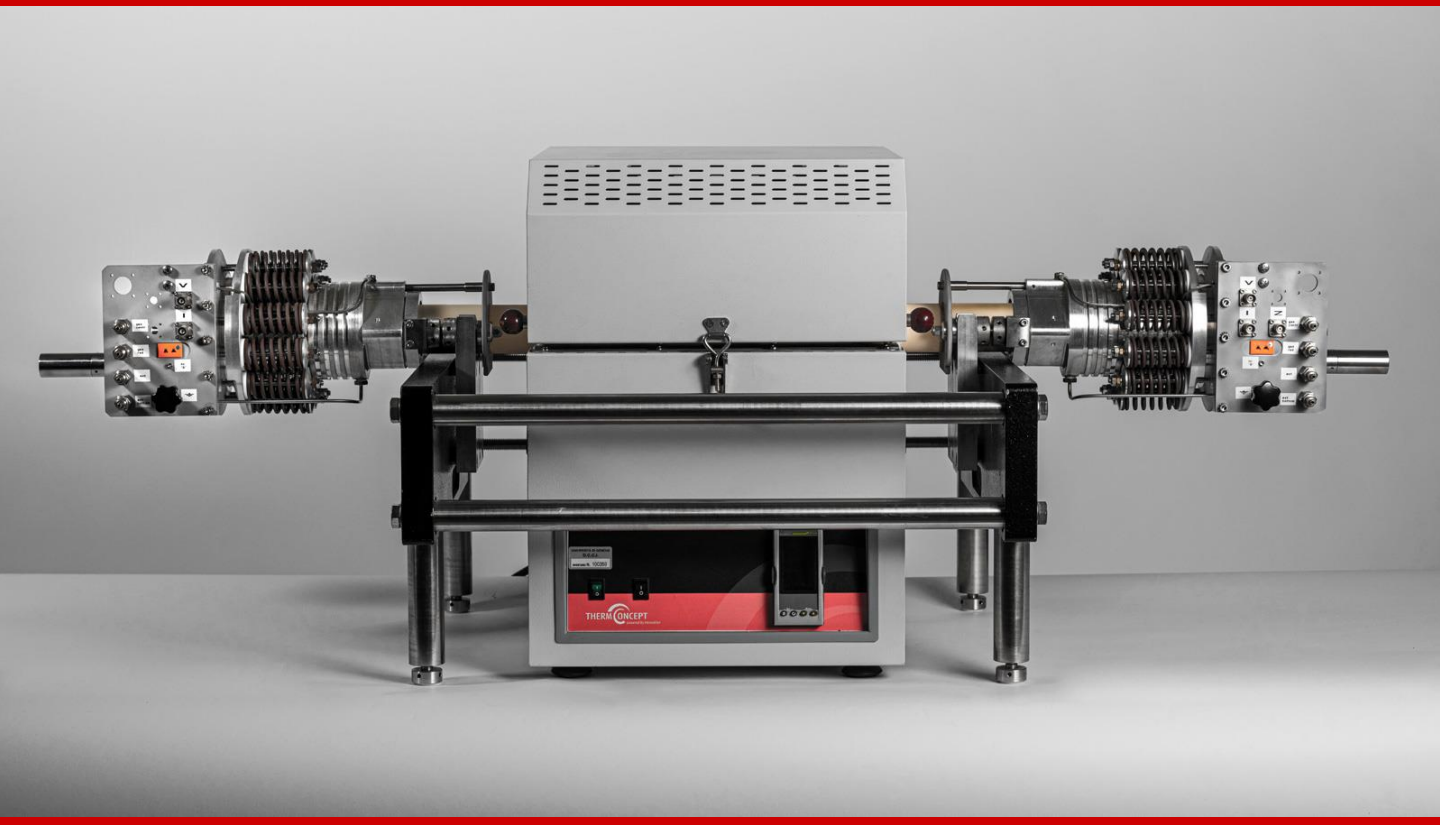
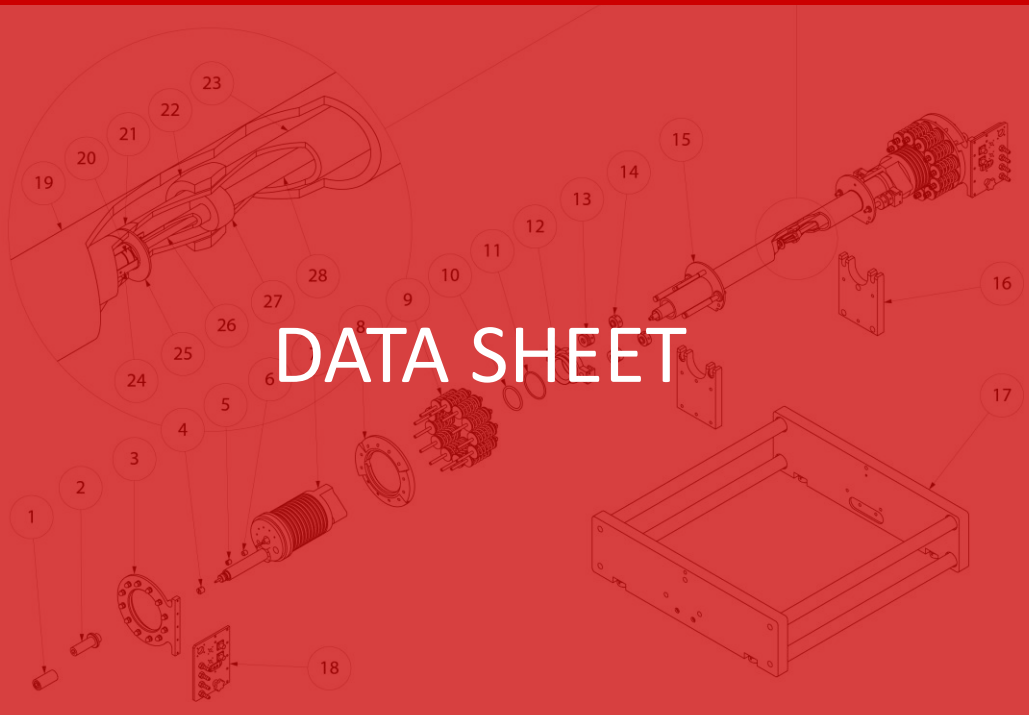
REAL LIFE TESTER





DATA SHEET

ERGO

REAL LIFE TESTER

DATA SHEET

INTRODUCTION

Real Life Tester is a standard laboratory equipment created in collaboration with CNR and the University of Genoa and carried out as part of a European research project on SOFC fuel cells. In 4 years of tests carried out at the university, however, a variety of fields of use have been validated.

HOW IT WORKS

Real Life Tester is the only standard equipment capable of simultaneously submitting a sample of material to:

- **PRESSION** up to **10 bars** with 2 atmosphers (1 different gas per side of the sample)
- **TEMPERATURE** up to **1.050 °C**
- **CURRENT** up to **1 A/cm²**
- **DURATION** of test cycles up to **10.000 hours**

Real Life Tester reproduces (and amplifies) in the laboratory the operating conditions of materials used in components subjected to multiple atmospheres even aggressive, high pressure, high temperature and polarization. It measures the physical and electrochemical phenomena that cause deterioration and saves in real time the data collected in the local network. The University of Genoa, for example, discovered and measured phenomena not included in the calculation formulas in studies on SOFC fuel cells, and this has led to reconsider some design hypotheses.

THE MATERIAL SAMPLE

The material sample is placed in a housing inside the machine after a dedicated preparation, it has a circular shape and complies with the following dimensions:

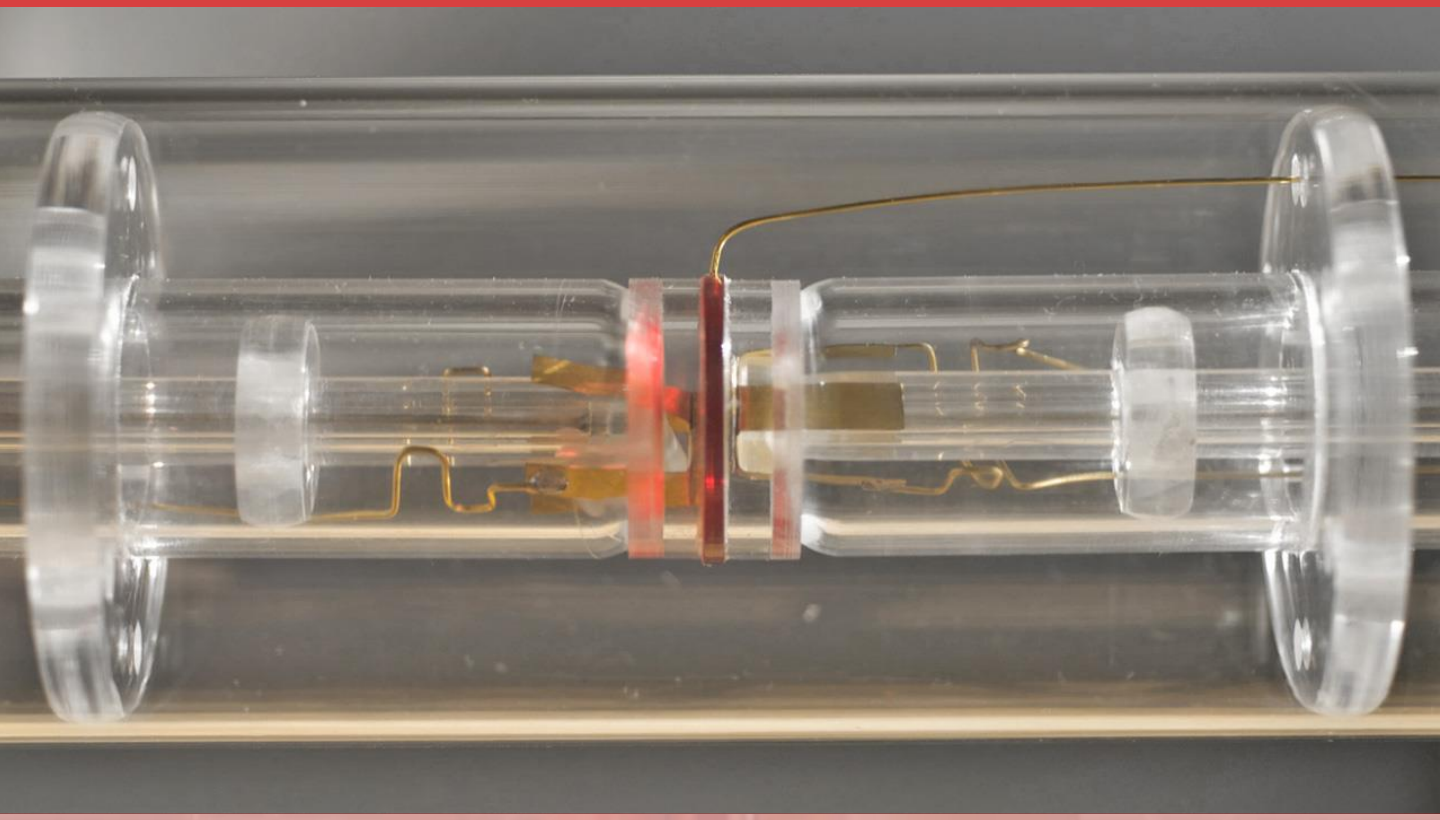
- **DIAMETER** **25 mm**
- **THICKNESS** **from 1 to 5 mm**

REALTIME DATA AND 5-POLE MEASUREMENTS

Throughout each test cycle a multi-channel workstation measures with 5 poles the electrochemical properties of the sample and makes the data available on the network. The 4-pole measurement of the material resistance is considered a very effective method, the addition of a fifth pole allows to separate the contributions and monitor the behaviour of the sample on each face.

REAL LIFE TESTER

DATA SHEET

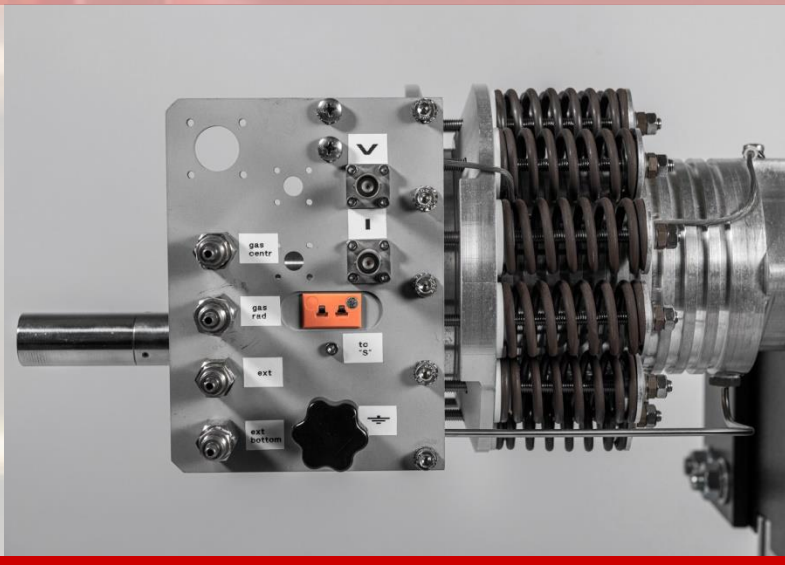


Detail of the reproduction of a sample of material inside the gas chambers and in contact with the 5-pole noble metal electrodes. In reality the chambers are not transparent since they are made of pure alumina ceramics. This material is used for its non-deformability at high temperatures.

DESIGNED FOR INDUSTRY 4.0

Real-time measurement and saving of collected data in a local network allows easy connection to logics of production automation.

A powerful software allows to analyze and display realtime graphs of the collected data and each test cycle can also be monitored in remote.



REAL LIFE TESTER

ANALISI E APPLICAZIONI

OPTIMIZE THE TIME-TO-MARKET

Before Real Life Tester it was necessary to make the prototype of a new product to test it in the laboratory under operating conditions, entailing high research and development costs. Today it is sufficient to submit a small sample of material to all forces simultaneously and analyze the results, obtaining in a few weeks what previously took years.

EXAMPLES OF APPLICATION

A non-exhaustive list of use cases that is possible to analyse with Real Life Tester:

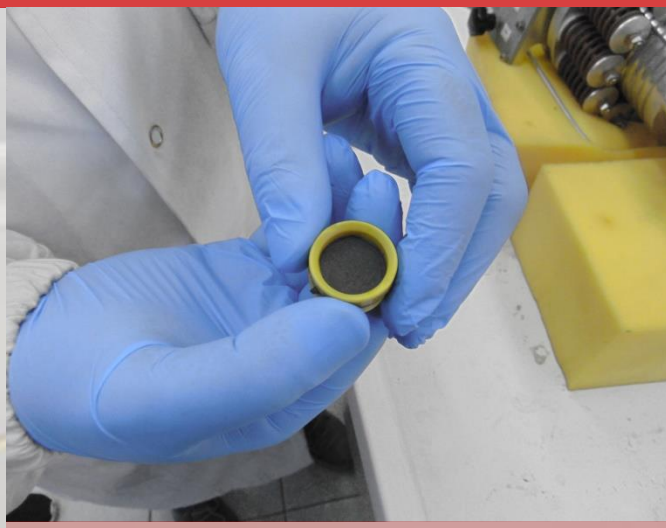
- SOFC and SOEC fuel cells
- Metals and coatings
- Ceramics and glass
- Metal-ceramic interface
- Simulation of SOFC stacking
- Simulation of heat exchanger components
- Simulation of hot exhaust gas components
- Simulation of vacuum conditions

EXAMPLES OF ANALYSIS

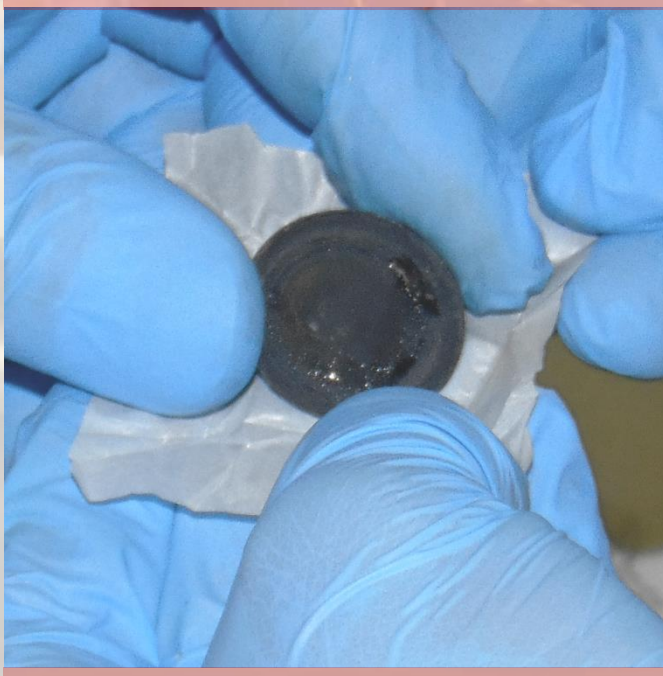
- Chemical and physical resistance under operating conditions
- Monitoring of microstructural variations
- Performance Calculation and Life Time Cycle
- Dry and steam oxidation rate
- Wear-dependent performance variation
- Suitability, reactivity and stability of coatings

ELECTROCHEMICAL MEASUREMENTS

- Electrochemical Impedance Spectroscopy (EIS)
- Area-specific resistance measurements (ASR)
- I/V curve measurement
- OCP curve measurement



Detail of a new material sample during the insertion process inside the gas chambers of Real Life Tester.

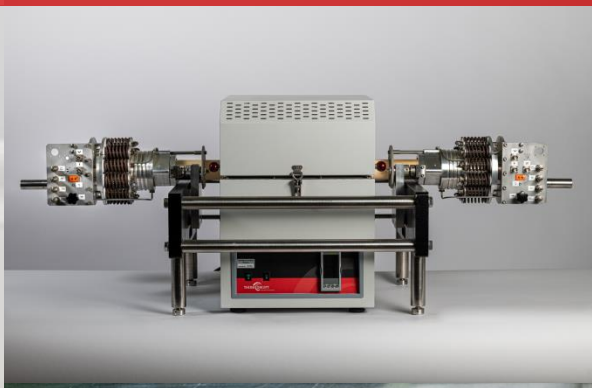


Detail of a sample of material extracted from Real Life Tester, visibly deteriorated after a test cycle.

REAL LIFE TESTER

EQUIPMENT

REAL LIFE TESTER
The analysis equipment into which the sample of material is inserted to subject it to temperature, pressure and polarization.



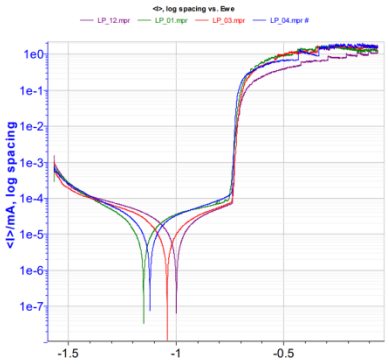
GAS PLANT
Allows the atmospheres used in the tests to be fluxed in the 3 gas chambers (2 in contact with the material sample and 1 for safety).

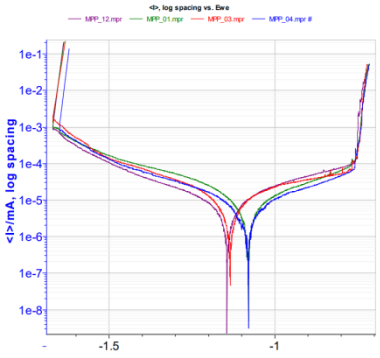
MULTI-CHANNEL WORKSTATION + SOFTWARE
It allows to polarize the sample, acquire electrochemical measurements, control data acquisition locally and remotely.

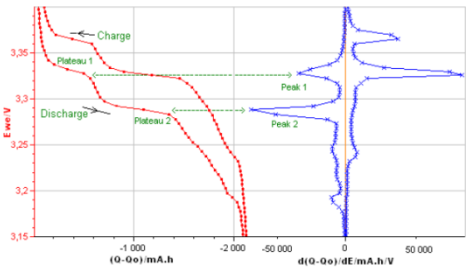
ELECTROLIZER (Optional)
It allows to generate hydrogen to be used in the tests on material samples.

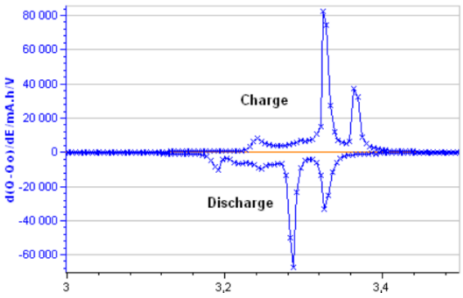
REAL LIFE TESTER

SOFTWARE







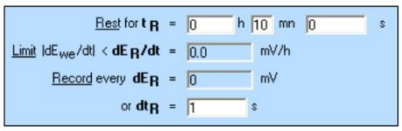


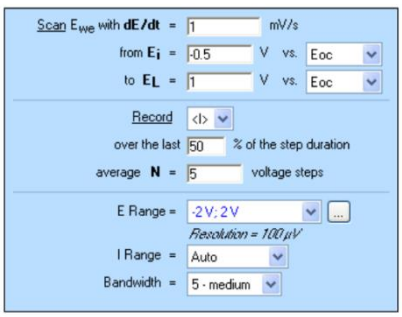
POWERFUL SOFTWARE TOOLS TO INVESTIGATE THOROUGHLY

The Real Life Tester Workstation is equipped with a powerful software tool that allows you to program tests, analyze and process the data collected.

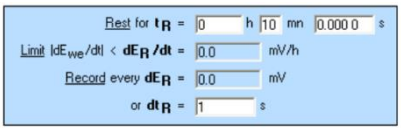
OBSERVE IN REALTIME THE EVOLUTION OF DATA

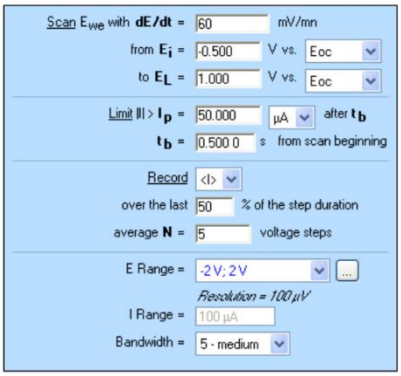
You don't need to wait months to get results. While the test is in progress you can analyze the real time data and view the graphs that draw the evolution. The values of the 5-pole measurements on the sample made during the entire test cycle are saved and made available on the local network.





(dE/dt ~ 100 µV / 100.0 ms)
(dEN ~ 500 µV)





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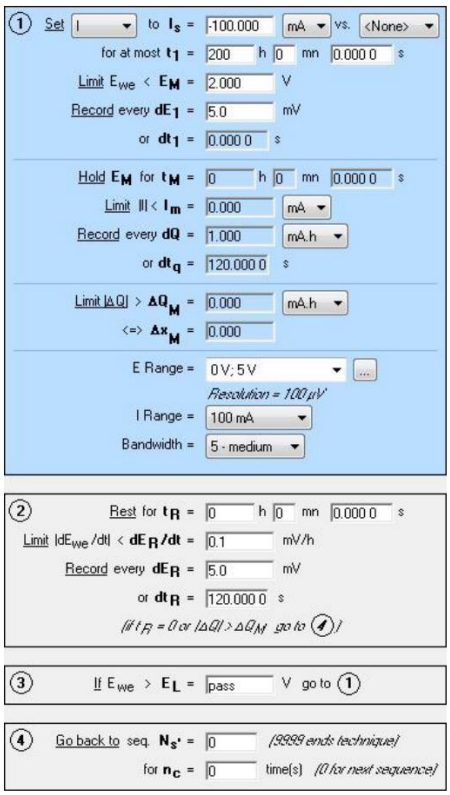


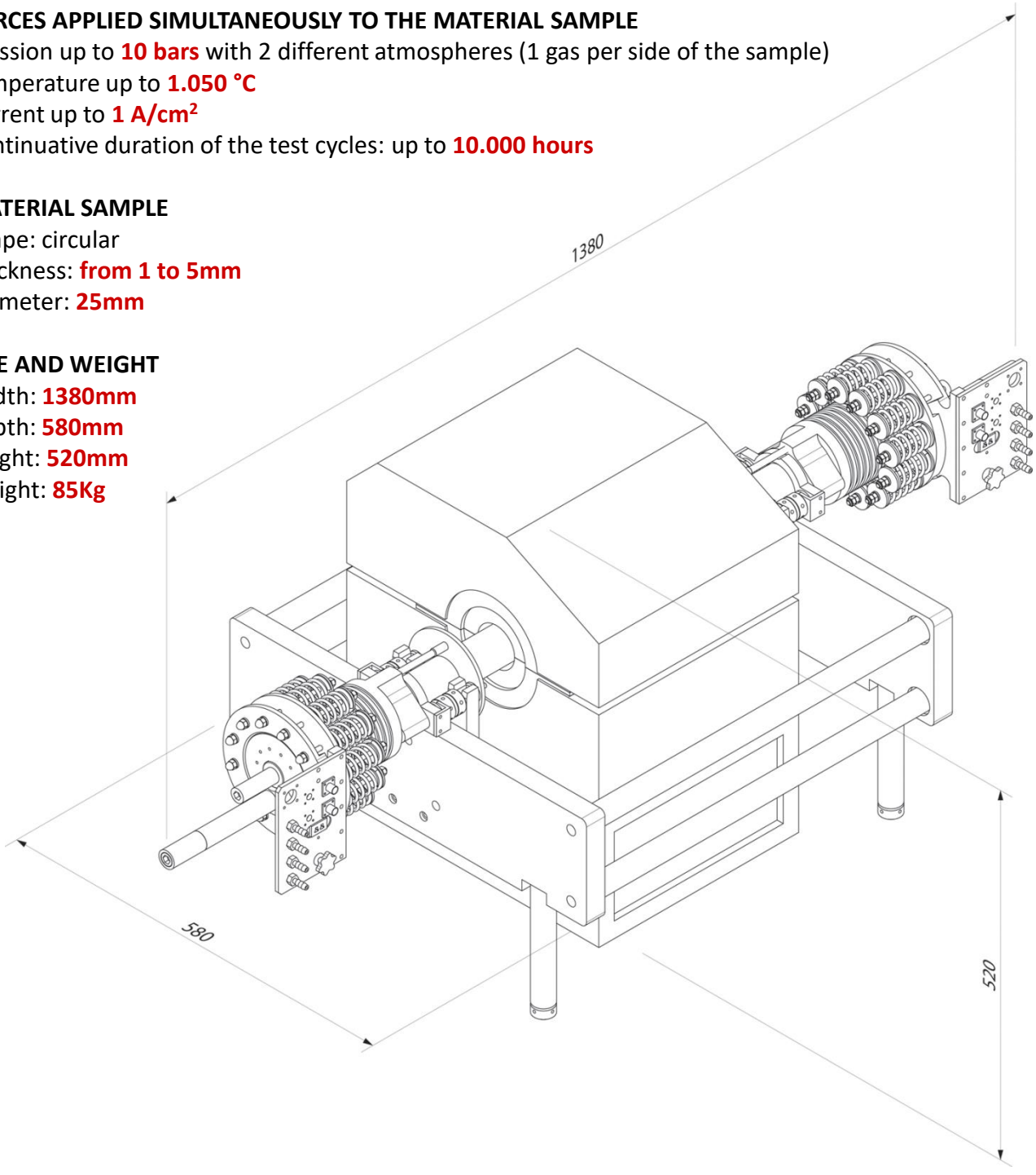
REAL LIFE TESTER

SIZING

FORCES APPLIED SIMULTANEOUSLY TO THE MATERIAL SAMPLE
Pression up to **10 bars** with 2 different atmospheres (1 gas per side of the sample)
Temperature up to **1.050 °C**
Current up to **1 A/cm²**
Continuative duration of the test cycles: up to **10.000 hours**

MATERIAL SAMPLE
Shape: circular
Thickness: **from 1 to 5mm**
Diameter: **25mm**

SIZE AND WEIGHT
Width: **1380mm**
Depth: **580mm**
Height: **520mm**
Weight: **85Kg**



CONSUMPTION

Peak power consumption: **1.767W** (**1.991W** with electrolyzer)
Power supply: **220V AC**

The peak consumption is distributed as follows:

- **OVEN** : **from 0 to 1.500W** (consumption depends on the operating temperature)
- **WORKSTATION**: **267W**
- **ELECTROLYZER** : **224W** (optional, used for hydrogen production)

WORKSTATION MULTICHANNEL
Technical specifications:

VOLTAGE
Compliance: ±10V;
Voltage control: ±10V adjustable; [0;20] V (standard); up to 60V with booster.
Resolution: 5µV on 200mV range

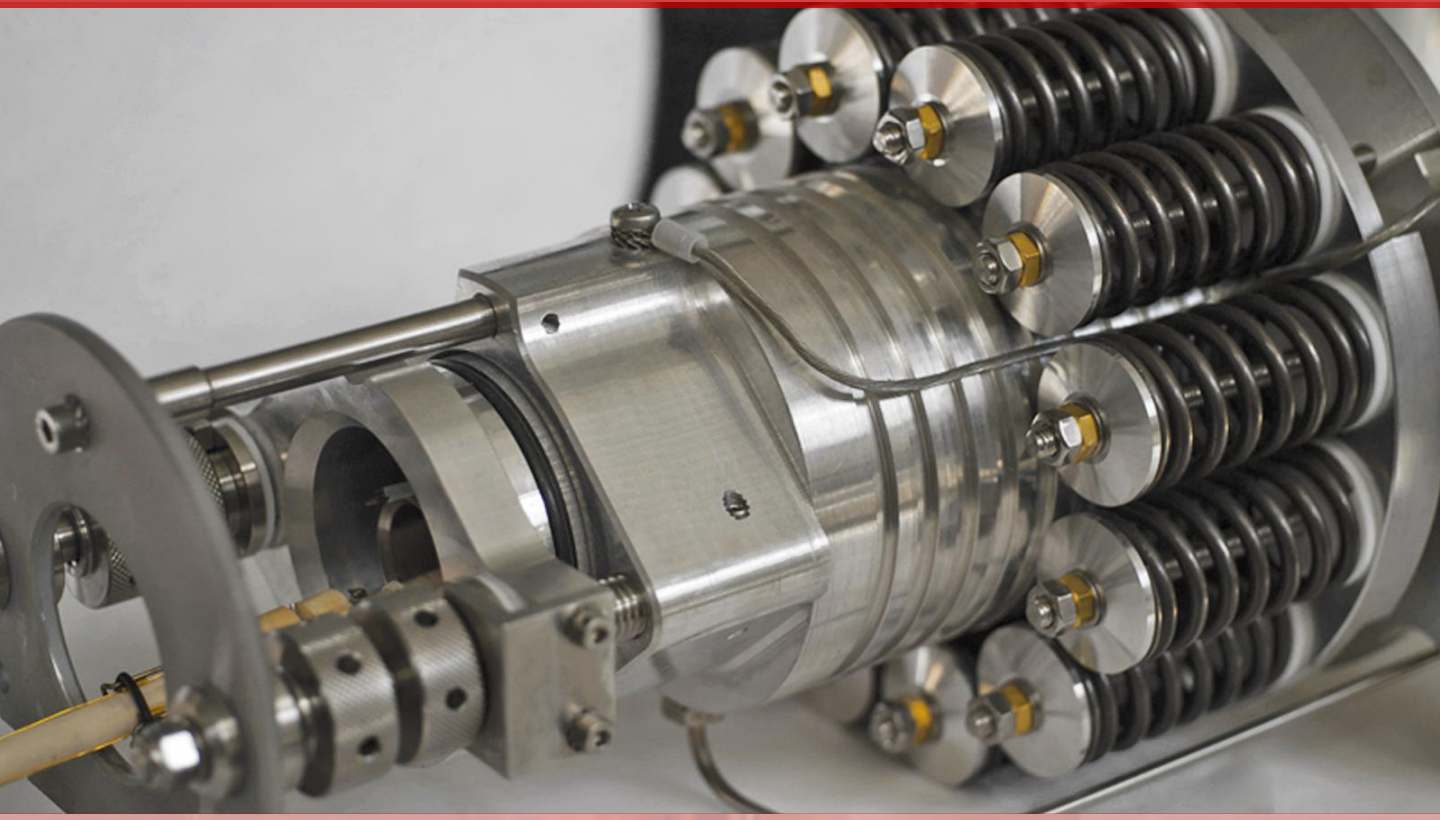
CURRENT
Range: da 400mA a 10µA (standard); fino a 1nA (Low Current).
Maximum current: ±400mA; up to 800A con booster.
Resolution : 0.760nA; up to 76fA (Low Current).

EIS (Electrochemical Impedance Spectroscopy)
Frequency range: from 1MHz to 10µHz
Current range: from 10µA to 1A

ACQUISIZIONE DATI
Minimum sampling interval: 20µs;
Stability control mode (7 bandwidths)
Up to 5 channels
RJ45 LAN network connection
Remote control

REAL LIFE TESTER

MAINTENANCE



Detail of a side heads, component that seals the gas chambers in which the sample is inserted.

MAINTENANCE 100% SELF MADE

The ordinary maintenance of Real Life Tester is very simple and is performed by the same personnel who use it. The few components subject to programmed replacement are in fact disassembled every time a new material sample is inserted.

ZERO CONSUMABLES

The machine requires a very low use of consumables and is equipped with an adequate supply of o-rings, rilsan or teflon tubes and pure alumina ceramic rings used to seal the material sample in combination with a special mastic.

HIGH SAFETY CRITERIA

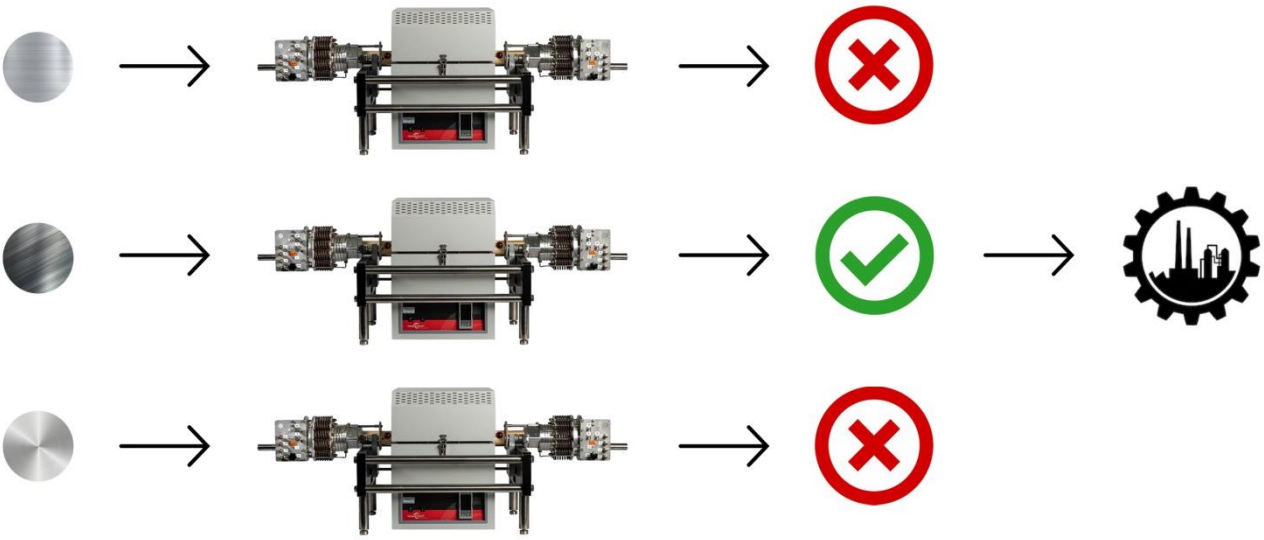
The main components to be replaced over many years to ensure safety conditions are the gas chambers made of pure alumina ceramic tubes.

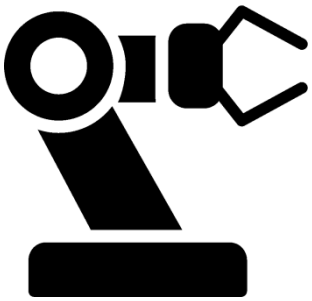
REAL LIFE TESTER

CLUSTER ANALYSIS

RIDUCI FINO A 5 VOLTE IL TIME-TO-MARKET

By placing a cluster of Real Life Testers to work in parallel on different candidate samples, after a single cycle of tests it will already be possible to compare the data collected on all materials and choose the most performing one under operating conditions.





CONNECTED TO THE PRODUCTION

Thanks to the real-time availability of data collected on the network, Real Life Tester can also be easily integrated into production automation processes..

REAL LIFE TESTER

REAL LIFE TESTER HAS BEEN DEVELOPED IN COLLABORATION WITH

Consiglio Nazionale delle Ricerche

UNIVERSITÀ DEGLI STUDI DI GENOVA

REAL LIFE TESTER HAS PRODUCED DEMONSTRABLE RESULTS IN THE FOLLOWING EUROPEAN RESEARCH PROJECTS

AD ASTRA

Accelerated Stress Tests and Lifetime Prediction for Solid Oxide Cells

https://www.ad-astra.eu/

Partner Companies: **SOLIDPOWER SPA** (Italy), **SUNFIRE GMBH** (Germany).

Partner Research Institutions : **ENEA** (Agenzia Nazionale per le Nuove Tecnologie, l'Energia e lo Sviluppo Economico Sostenibile, Italy), **UNIGE** (Università di Genova, Italy), **EIFER** (European Institute for Energy Research, Germany), **CEA** (Commissariat à l'Énergie Atomique et aux Energies Alternatives,France), **EPFL** (École Politechnique Federale de Lausanne, Switzerland), **DTU** (Danmarks Tekniske Universitet, Denmark), **UNISA** (Università di Salerno, Italy).

ENDURANCE

Enhanced Durability Materials for Advanced Stacks of new Solid Oxide Fuel Cells.

http://http://durablepower.eu/

Partner Companies: **SOFCPOWER SPA** (Italy), **SCHOTT AG** (Germany), **HTCERAMIX SA** (Spain), **MARION TECHNOLOGIE** (France).

Partner Research Institutions: **UNIGE** (Università di Genova, Italy), **DLR** (Deutsches Zentrum für Luft- und Raumfahrt, Germany), **IREC** (Institut de Recerca en Energia de Catalunya, Spain), **CNRS-BX** (Centre National de la Recherche Scientifique, France), **EPFL** (Ecole Polytechnique Fédérale de Lausanne, Switzerland), **IEES** (Institute of Electrochemistry and Energy Systems, Bulgary), **CEA** (De la recherche à l'industrie, France), UNIPI (Università di Pisa, Italy).

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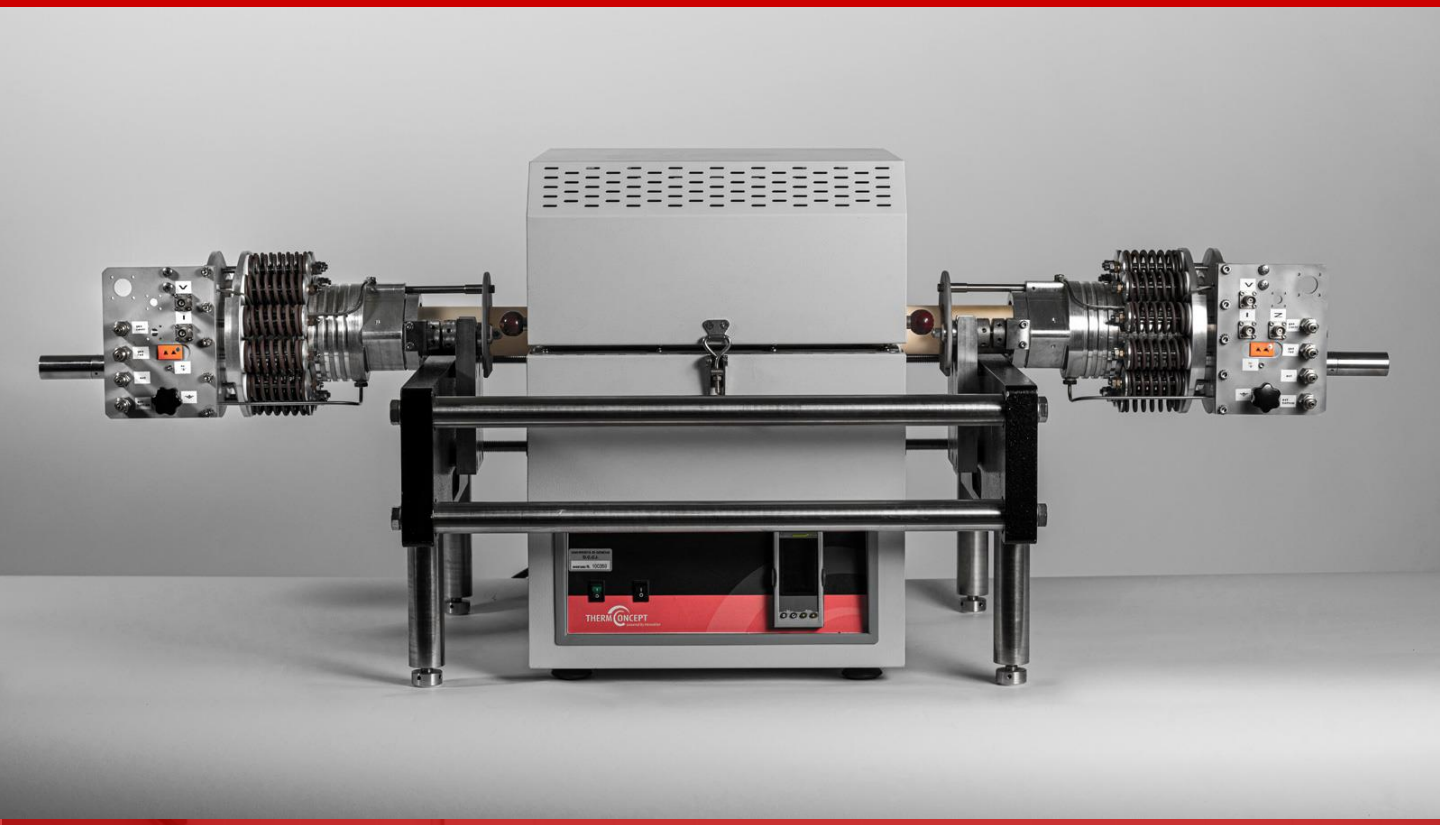

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Real Life Tester

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