ibertest

ADVANCED TESTING SOLUTIONS

# Testing Solutions for Metallic Materials

ISO 9001:2000 SGS

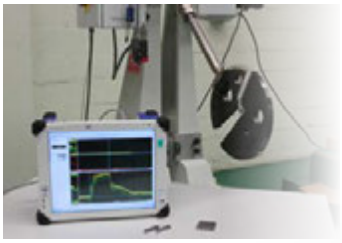
ACREDITADO POR ENAC

Certificado Nº ES04/0611

## Quality Engineering since 1970

- Tailored engineering: testing technology focused on customer needs.

- Confidence and reliability: Manufacturing in accordance with the most demanding quality criteria, and nternational Testing Standards.



- R+D+innovation: committed with continuous improvement of our products.

- After sales service: accompanying and supporting customers in their activities with calibration, predictive and preventive maintenance, reparation, up-dating and modernization services.

- Calibration Laboratory: ENAC (member of ILAC). Accredited

## Headquarters

S.A.E. IBERTEST
Ramon y Cajal, 18-20.
28814 Daganzo de Arriba
Madrid · Spain

# Testing solutions for metallic materials

## INTRODUCTION

Any manufacturer of metallic materials, or a research centre, needs to learn about the mechanical properties of their particular product, independently of the type of its dimensions and chemical composition.

The knowledge about the behavior of such particular material / product under mechanical loads is achieved performing mechanical and destructive tests, among other evaluations.Each metallic material is characterised by a series of distinctive features and particularities.

For this reason, the tests has to be performed using appropriate procedures and devices, which, in many cases, are specific to each particular material.

Manufacturers must demonstrate the properties of their product, following a wide variety of international regulations and standards, such as EN, ASTM, JIS, SAE, among others.

IBERTEST offers to manufacturers and laboratories dedicated to the inspection of metallic materials a large range of reliable, high-quality solutions, which can be adapted to the quality control requirements of any product and application.

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## Steel and other metals

## PROPERTIES AND APPLICATIONS

Success of metals in engineering applications is based on their capacity to satisfy design and service requirements better than other materials. In addition, their manufacturing process allows to reach high quality products with proper dimensions.

Mechanical properties research and definition is the main focus of IBERTEST solutions since more than 40 years.

Those properties are obtained studying the behavior of a material or product under certain external load applications.

Through different types of testing, we can calculate and evaluate properties such as:

- Modulus of elasticity.
- Elastic limit.
- Elastic and plastic deformation
- Fatigue and dynamic behaviour
- Hardness
- Fracture origin and evolution

Mechanical properties are due to metal´s microstructure (for example, size of grain and cualitative and quantitative phase distribution), type of crystalline structure (that is, the arrangement of the atoms), elements composition, proportion and solubility(for example, element containing alloys, level of impurities), manufacturing and treatments, etc.

Destructive tests provide information from the real product which are not always the same than theoretical calculations and expectatives

Magnetic properties, thermal and electric conductivity, corrosion resistance and other physic and chemical characteristics are typically determined via particular methods where an external load is not required or it is not the main object of study.

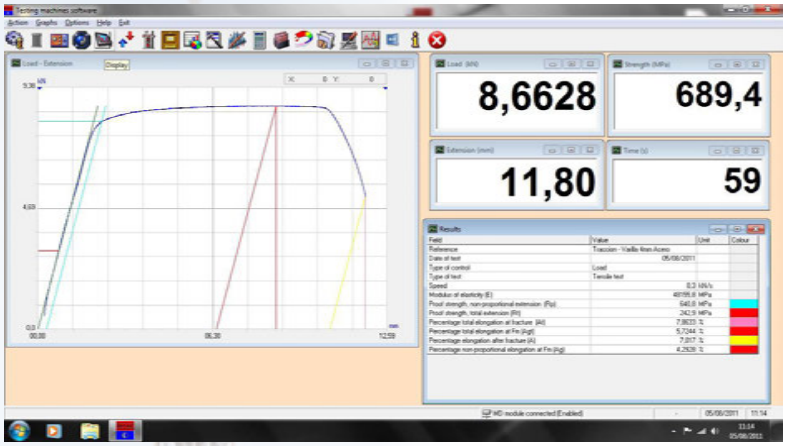
## Steel and other metals

# TENSILE TEST

In the tensile test, the stress-strain curve, is obtained combining in real time load and deformation values of the sample being tested. Stress is obtained by dividing the load by the initial sample´s cross-section.

IBERTEST´s electronic system assures, with its closed loop operation, an accurate and reliable follow up of the test command. Test command can be load, displacement or deformation. Over 1000 servocontrol loops are performed in one second.

In parallel WINTEST software registers the test´s values with a high sampling frequency, calculating all material´s parametres demanded by the standard in a quick and precise way.





High performance and precise load, displacement and deformation transducers, together with top level mechanical and hydraulic elements and a powerful and versatile WINTEST software, allows the user to reach the highest levels of quality in mechanical tests results.

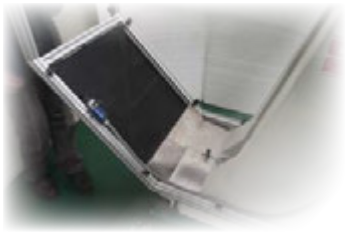
## Steel and other metals

# IMPACT TESTS : CHARPY - IZOD

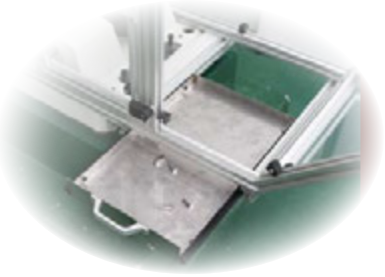
These tests are used to determine how a material behaves when high speed loads are applied over it.

The most widely used test is the CHARPY, on normalized specimens, with a V-shaped or U-shaped notch. Charpy pendulums measures the resilience of the material through an impact test with a defined speed. The result is the amount of energy that a material is able to absorb before permanent deformation (plastic deformation), occurs.

IBERTEST offers several test solutions through its Impact Pemdulumd PIB series, with impact energies up to **750 J**. IBERTEST PIB pemdulums offer the latest technology, such as its new tactile interface, which simplify the job and calculates, automatically, the test results.



Experienced users appreciate the advantages of IBERTEST pendulums, which assures accurate results, maximum productivity due to a reduced test time process, friendly and ergonomic interface and total safety for users according CE directive



PIB series allows several impact energies in the same machine, 150,300, 450 and 750 J can be combined in the same testing solution.

The equipment performs an automatic detection of the pendulum energy, to assure correct calculations and results.


Impact test pendulum PIB

Other optional characteristics:

- Instrumented striker for load-deformation curve definition and accurate energy calculation
- Automatic feeding of test specimens.
- Low temperature tests.
- Notching-tool for preparing test specimens.

Steel and other metals

## TENSILE AXIS ALIGNMENT OF TEST FRAME

Currently, the aeronautic, automotive and defense sector providers, among others, must exceed strict audits, such as the AC7122 established by NADCAP. These audits requires several verifications over the testing machine to grant the perfect results of tests. To meet the requirements demanded for mechanical tests, whether they are over metallic materials or not, the alignment of the testing-machine´s axis and the bending capacity has to be accurately demonstrated, according to regulation ASTM E1012.

The misalignment of the testing-machine´s axis may be due to several factors:

- Position of the mobile crosshead / actuator in relation to the test frame.
- Excessive tolenrances in the manufacturing process.
- Wear and replacement of clamping elements.
- Damage or malfunction of the test accessories.


### IBERTEST´S ALIGNMENT SYSTEM "ALIGNTEST"

SAE IBERTEST has developed a solution which is easy to implement. This solution allows the user to achieve correct alignment of the testing-machine axis. The alignment system Align-test is made up of the following components:

ALIGNMENT VERIFICATION

- Instrumented tensile specimen, with 8 strain gages, arranged in such a way that they are capable of detecting the concentricity and angle faults of the axis.
- Data adquisition system, with 8 independent data channels which receive and process signals from the strain gages to the system´s computer.
- The "Win-Align" software: to evaluate in real time, and in both graph and numerical format, the misalignment values established by the regulation.


ALIGNMENT CORRECTION

- Mechanical device, placed between the load cell and the machine's frame. It is capable to correct which provides 4 Degrees of Freedom in order to correct the misalignment in a very exact and precise way. This opperation is aided by the data given by the software.

## Thick Sheets

### TENSILE TEST ON THICK SHEETS AND LARGE SECTION SPECIMENS

Tests performed on large section test specimens, such as laminated sheets, requires machines which have a capacity greater than 1000 kN, in addition tensile devices which can fit the dimensions of these test specimens.

IBERTEST´s **UMIB** and **IBMT4** servo-hydraulic machines, are the proper solution for steel manufacturers and research centers. Their maximum capacity can reach and even exceed 3000 kN.

IBMT4

UMIB

### HARDNESS

The hardness test measures the level of difficulty of introducing an indenter into a specific type of metal.

IBERTEST can provide stand alone hardness testers or attachable hardness testing accesories that can fit on several machines.

Thick Sheets

## FRACTURE MECHANICS

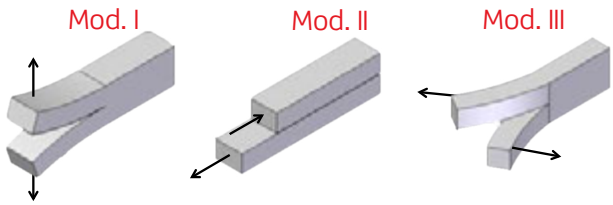
Despite the significant quality-control methods which are used for the inspection on materials, the complex, structural elements can produce discontinuities and faults.

In order to study these discontinuities on metallic materials, the fracture mechanism theory must be used.

This theory assumes that all the solids contains cracks and defects (final product is never perfect), at least as big as the maximum resolution of the inspection device which is being used in the quality control procedure.

There are analysis which has to be applied according three methods of crack propagation:

I. Tensile opening.
II Tangential or shear stress.
III. Tangential stress on the plane (tearing)

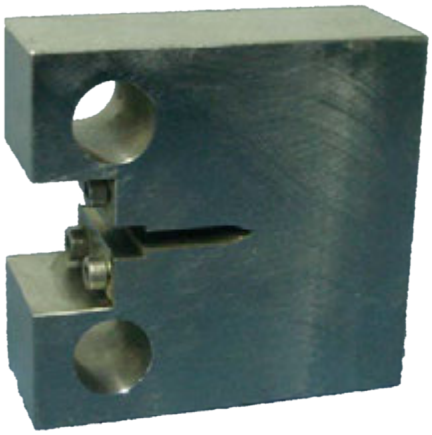


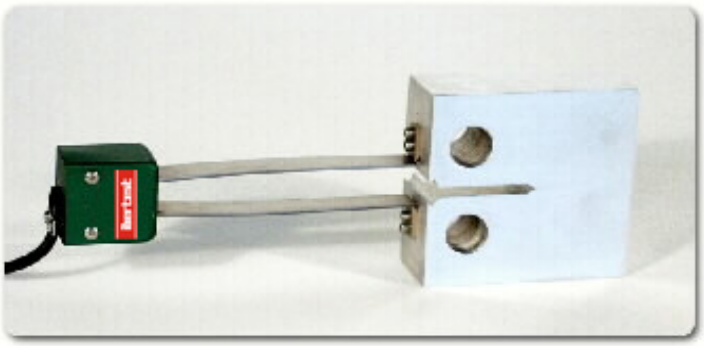

The breakage criteria is characterised by the intensity factor of stress (K). When the critical amount of stress intensity is reached (Kc), this value corresponds to the strength of the fracture of the material being assessed.

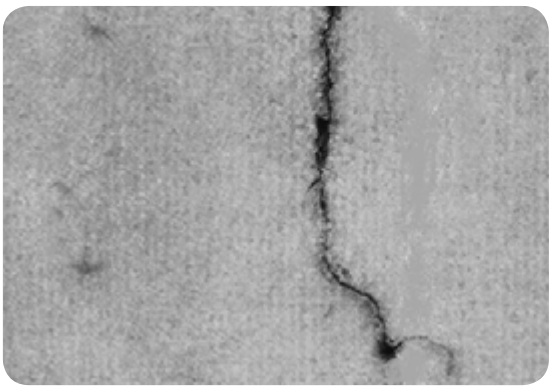
IBERTEST provides machines to evaluate the fracture strength as per method any method.

$K_{IC}$ can be determined by means of a tensile test of a specimen type CT (Compact Tension) and flexural strenth tests of SENB (single-edge notch bend) specimens, as well as by the determination and study of the CTOD (Crack Tip Opening Displacement).

Aditionally, IBERTEST offers solutions for studying the tensional state that materials can be subject to, depending on the size of the crack, as well as the evolution of the damage in the metal, in order to determine their life span.







## Steel and other metals

# RANGE OF MACHINES FOR EACH PRODUCT

**LAMINATED SHEETS.** Large sized specimens.

› Large capacity machine. **IB-MT4** 1500 - 3000 kN

**FLAT PRODUCTS.**

› Conventional tensile test. **IB-MT4, UFIB and EUROTEST** from 500 to 1000 kN.

› Impact test. Charpy PIB pendulum from 150 J to 750 J.

**COLD AND HOT ROLLED PRODUCTS.**

› *Determination of parametres* **n y r.** Precise preparation equipment for specimens and combined extensometry in 2 directions.

› *High temperature tests. Tensile test with furnace and creep test.*

**RODS AND LONG PRODUCTS.**

› Tensile test with extensometry.

› Test on steel bars for concrete reinforcement.

› Bending and un-bending test.

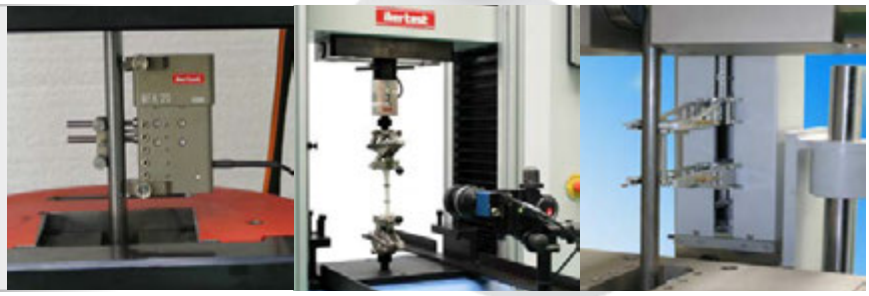
IBMT4


UMIB

EUROTEST


IB-CREEP

EXTENSOMETRY



## Cold-rolled products of steel, aluminum and others

# ANISOTROPY AND STRAIN HARDENING: DETERMINING THE N AND R VALUES IN METALLIC SHEETS

In the tensile test over sheets and other cold laminated products, special properties has to be determinaed in addition to conventional ones obtained on tensile tests. A consequence of its manufacturing process, anisotropy and cold hardening effects appear and has to be evaluated via n and R coefficients calcultaion.

TESTCOM

These coefficients characterise the **anisotropy**[1] and cold hardening effect of the sheet and provide information about the material´s aptitude to be plastically deformed.

IBERTEST´s series TESTCOM and EUROTEST are electromechanical machines for low and medium-high loads, ideal for the characterization of these materials.

Electronics carry out a very precise control of the test's velocity test and rate of load application.

Software calculates, basing on the information provided by axial and transverse extensometers, the n and r values.

**1 Anisotropy:** *General property of the material, according to which some physical properties depend on the direction. It is related to the variation of the atomic or ionic distance, according to the crystallographic direction. Anisotropy is usually more pronounced in metals which are laminated, shaped or extruded, in which the grain or fibre structure tend to be aligned in the main working direction.*

## Cold-rolled products of steel, aluminum and others


# PREPARATION OF METAL SHEET SPECIMENS VIA HYDRAULIC PUNCHING

**The most common manufacturing method of thin sheets and thin metallic laminated products, is cold lamination (or rolling).**

In this process, a cold deformation is applied, which produces a reordering of the metal fibres, as well as the appearance of internal tensions and hardening.

All of these changes in the internal structure has a great influence on the anisotropy of the material. In order to characterise the material correctly, it is needed to compare the results obtained from specimens which have been extracted longitudinally, perpendicularly, and at an angle of 45 degrees from the laminating direction.

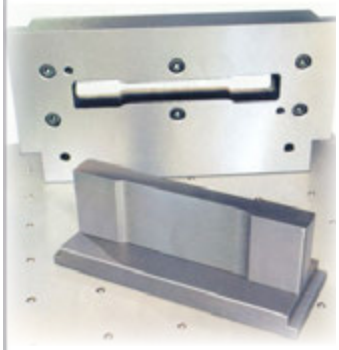
When characterising the material by means of a tensile test, standardised dog-bone specimens must be extracted. **The quality of the result of the tensile test is proportional to the quality of the specimen**.

The best machine will obtain results not valid, due to that bad quality of sample preparation. Results will be affected for cold hardening effects.

### PREPARATION OF SPECIMENS VIA A HYDRAULIC PUNCHING MACHINE

Our solution allows to obtain, via punching, dog-bone specimens in the three common extraction directions.

Punching has proved to be the most simple and quick procedure, which produces the best results for the preparation of metallic sheet specimens. It is valid for materials with a resistance of up to 1500 N/mm$^2$ .



Our system reduces the cold hardening effect to the minimum, thanks to special shaped punching elements and very low loap application velocity, minimizing the cold hardening effect.

In traditional cutting systems, the area affected by the cold hardening can reach up to 35% of the specimen´s thickness, which is not acceptable fot the tensile test.

**“Our system ensures that the area affected by the cold hardening is less than 10% of the specimen´s thickness.”**

Specimens can be created pursuant to regulations ISO, EN, DIN, JIS, ASTM, among others. The punching frame, shaped as a “C”, of the machine allows for the use of large-dimension base materials.

When the specimens have to created from big, very heavy sheets, it is possible to incorporate (optionally) some rollers on the table, which facilitate the positioning and movement of the sheet.

Cold-rolled products of steel, aluminum and others

# GRINDING MACHINE FOR SHEET SPECIMENS

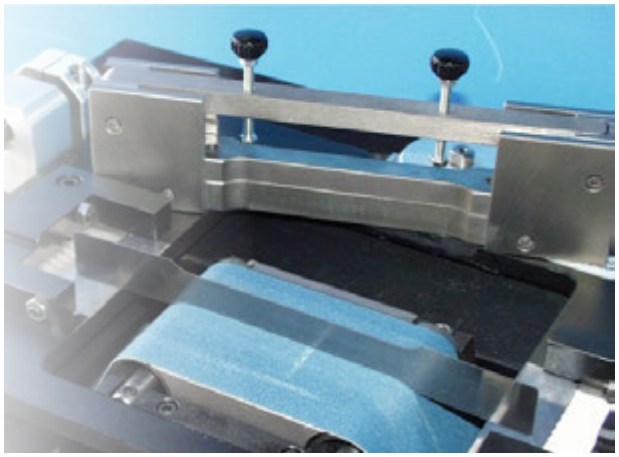

All international testing regulations: EN, ASTM, GHOST, ISO, DIN, JIS, warn that the damage caused to the edges of the specimen (cold hardening) must be eliminated prior to the tensile test.

If the specimen preparation system introduces too much hardening via cold deformation, or a high quality specimen is required, IBERTEST offers a sander-grinder machine, which allows customer to rely on test results and be sure that no deviation will be introduced due to sample preparation.

## ELIMINATING BORDER DAMAGE TO THE SPECIMENS WITH A GRINDING MACHINE SPECIFIC FOR THIS APPLICATION.

BERTEST grinder eliminates the affected area quickly and simply, guaranteeing a high quality of the finished product.

A final paralelism better than 0,02 mm (0,0008") is granteed, according to the recommendations of the IDDRG (International Deep Drawing Research Group).



The use of a specimen-holder allows for the grinding of several specimens simultaneously.

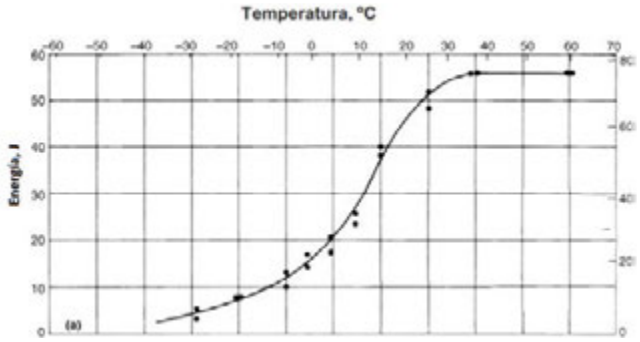
The specimen-holder admits a set of specimens with a total thickness of up to 12 mm.

Once the specimen-holders are loaded and set up in their working position, it is possible to eliminate thicknesses of between 0,2 and 0,6 mm within a time period of less than two minutes.

In this way, the time taken to grind 20 specimens is approximately 4 minutes, including the rotation time used in order to grind both sides of the specimen.

## Structural metals

# FRACTURE IMPACT TEST




Despite the fact that, during the tensile test, information is obtained about the strength of the material, the results of tensile resistance cannot be extrapolated to predict the material´s response to fracturing.

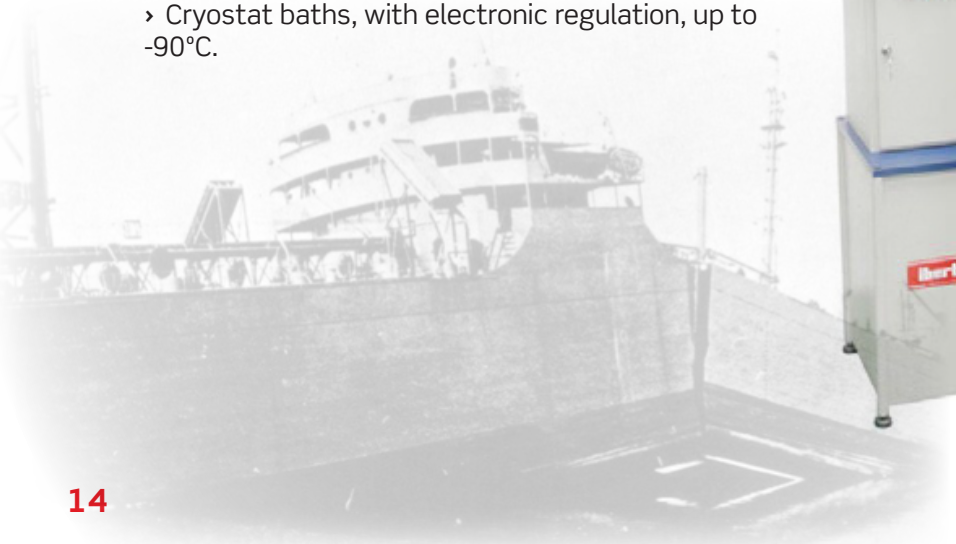
Under certain circumstances, metals which are normally ductile can fracture without any plastic deformation. In this case, the impact resistance test is the most suitable. This is because the impact test conditions are the most severe with respect to the fractures. These are:

- Deformation at relatively low temperatures.
- High velocity of deformation.
- Triaxial state of strains (introduced via a notch in the specimen).

The energy that a material is capable of absorbing is not constant and varies, among other factors, according to the temperature. Performing impact tests at different temperatures is very useful for determining the temperature at which the material changes from ductile to fragile. In the case of thick steel sheets, this vital fact has been known for years.


IBERTEST offers a complete range of impact testing solutions for fracture, providing:

- Impact test pendulums, PIB series.
- Specimen preparation, manual/automatic notching tool.
- Cryostat baths, with electronic regulation, up to -90°C.

## DETERMINING THE "CRACK TIP OPENING DISPLACEMENT": CTOD DEVICE

ASTM E1290, ASTM E1820, ASTM E813, ISO 12135, BS7448, are the main international standards to determine the fracture resistance of metallic materials. Results are obtaining by monitoring the development of a crack in the tip of the crack of the material being tested.

In these tests, the specimen rests on two supports, whilst the force is applied vertically on the specimen, via a load roller.

The testing device provided by IBERTEST is prepared to be used with any machine capable of applying compression load, with a controlled speed and an apropriate sensitivity. The bending device comprises two supporting rollers, with an adjustable distance with the help of a graded scale, and a third load roller. All of the rollers are made of high hardness steel (aprox. 40 HRC). Additionally, the rollers rotate freely around their axis in order to avoid the possibility of friction occurring between the rollers and the specimen´s surface. The extensometer, with its "clip-on" pins, has a special design, for being positioned easily and to remain stable throughout the test.

## HIGH TEMPERATURE TESTS

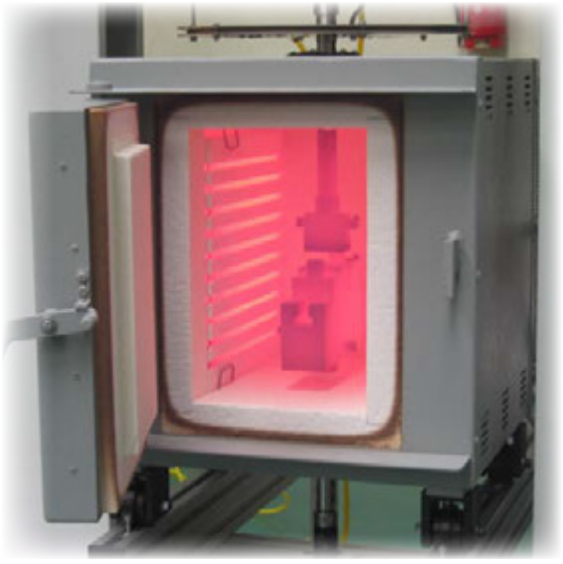
The effect of the temperature influence highly on the mechanical properties of the materials, modifying its endurance and reliability.

This influence is very important for any manufacturers providing products susceptible to work under different temperature conditions. In aeronautical, petrochemical, automotive, military and serveral other industries, the final product is exposed to severe changes of temperature during the use.

IBERTEST develops and supplies a complete spectrum of thermal cabinets and furnaces from -80 to 1650 °C.

High and low temperature extensometers , as well as special devices and adaptors used to perform tensile, compression and bending tests at extreme temperatures are designed and supplied to complete the capabilities of the testing solution

Fluency and relaxation effects at high temperatures can be studied with IBERTEST IB-CREEP machines.



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S.A.E. IBERTEST
Ramon y Cajal, 18-20.
28814 Daganzo de Arriba
Madrid · Spain

Tel: +34 91 884 53 85
Fax: +34 91 884 50 02
info@ibertest.com

www.ibertest.com

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