

A photograph of a SIGMAMETER automated instrument, showing a control panel with a digital display, a keypad, and several function buttons. The instrument is blue and white. The background is a dark blue gradient with a yellow and orange curved line on the right side.

SIGMAMETER automated

The unique
automated
Quality/Control
instrument
for ferromagnetic
compound
 σ_s determination

σ_s :
Specific
saturation
magnetization

Sigmameter

The magnetic specifications of a ferromagnetic compound may vary to a very large extent further to mechanical and/or thermal treatments. The variations in the magnetic specifications are taken into account by the specialist in order to study the evolution of some solid state transitions. Magnetic measurements offer high sensitivity and allow the detection of very subtle metallurgical events.

Applications

The Sigmameter is successfully applied for the determination of ferromagnetic compounds in both research and development as well as in quality control. It can measure the value of the specific saturation magnetization σ_s of a material in just a few seconds.

Units and values at 20°C		
	CGS system (EMU CGS)	MKS rationalized system
Mass.....m	g	kg
Magnetic saturation moment.....m	G.cm ³	T.m ³
Specific saturation magnetization..... σ_s	G.cm ³ .g ⁻¹	T.m ³ .kg ⁻¹
Nickel	54.5	68.5 X 10 ⁻⁶
Cobalt α	160	201 X 10 ⁻⁶
Fe α	217	275 X 10 ⁻⁶
Fe ₃ C α	132	166 X 10 ⁻⁶
Fe ₂ O ₃ γ	80	100.5 X 10 ⁻⁶
Fe ₃ O ₄	92	115.5 X 10 ⁻⁶
Fe ₁₂ O ₁₀ Ba	72	90.5 X 10 ⁻⁶
1 G. cm ³ .g ⁻¹ = 4 π 10 ⁷ T.m ³ .kg ⁻¹ MKS rationalized system		



Cemented carbide manufacturing

Cemented carbides are made by a sintering process using powder metallurgy technology. The main components are hard particles (which can be tungsten carbide, titanium carbide, niobium carbide, tantalum carbide) and a binder which is usually cobalt or nickel. Both these binders are ferromagnetic compounds.

They must be determined during the manufacturing process to find out whether there are any oxides in the powder before sintering, and for an indirect determination of the carbon content in sintered cemented carbide.

This analysis is done by comparing the theoretical value with the measured value. Determination of carbon content is the most essential control in carbide production and the Sigmameter is very useful for this purpose.

Magnet manufacturing

The raw product used in magnet manufacturing is usually a powder. The best method of checking its quality is to measure its σ_s .

This test is carried out by both the powder supplier and the manufacturer. The σ_s value is given as a purity criterion. σ_s determination is a standard quality control for all magnets made of ferrite and cobalt rare earth compounds before and after sintering.

The research and development of new metallic alloy magnets could not be achieved without investigating the σ_s .

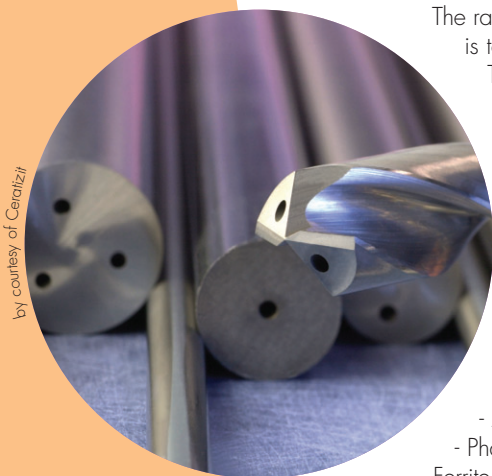
Metallurgy

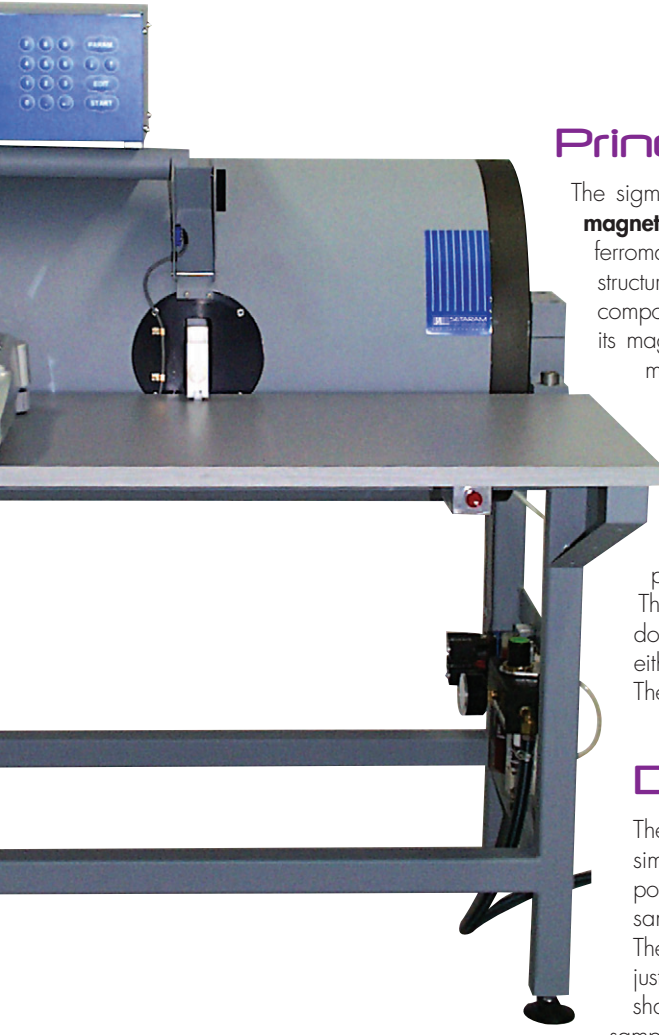
- Martensite determination in stainless steels.
- Investigation of the concentration of martensite in stainless steels under different strain rates
- Martensite determination after quenching
- Austenite determination
- Phase diagram investigation
- Ferrite determination in welding material

Other fields of application

- Geology
- Magnetic material control
- Cobalt or nickel determination in special compounds

The examples given are typical applications, but as with all techniques, new ones might be developed in the future.





Principle

The sigmometer is designed to measure the **specific saturation magnetization σ_s** of a material. This parameter characterizes a ferromagnetic phase and it is in principle independent of the structure and shape of the sample. When a ferromagnetic compound is in a magnetic field, it is magnetized. The value of its magnetization increases with the field and then reaches a maximum.

The specific saturation magnetization σ_s is the ratio of the maximum of the magnetic moment to the mass of the material. The magnetic moment is determined by driving a sample out of the magnetic field and measuring the induced e.m.f. in a coil.

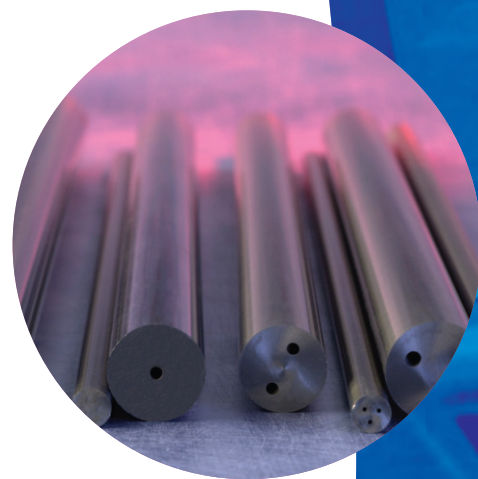
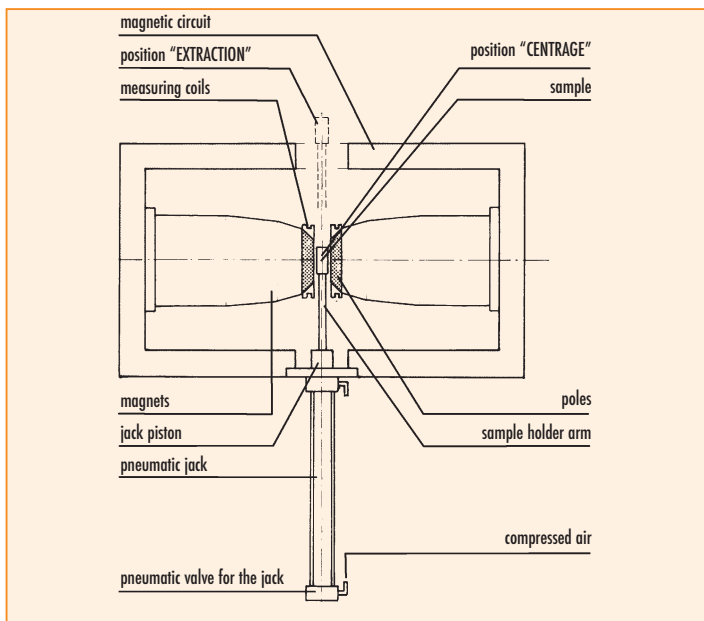
The integral is proportional to the σ_s value of the sample, provided that it was saturated in the field.

The microprocessor of the reading unit integrates the e.m.f. and does the required data processing. It calculates the value of either the σ_s or the content of the ferromagnetic phase. The value is read on a digital display.

Description

The principle operation of the sigmometer is based on a very simple electromagnetic property. The magnet box contains a powerful permanent magnet and a mechanical system to drive a sample in and out of the magnetic field.

The loading and unloading of the sample is easy and takes just a few seconds. The sample is slipped into a sample holder, the shape of which can be modified depending on the type of sample; if necessary, the holder can be removed rapidly in order to fit another one.



by courtesy of Certeza

The mass of the sample can be fed through an interface from an electronic balance into the microprocessor. The result is available as a digital signal. When it is fed into the printer, it is automatically printed. The data can also be reviewed on a PC in Excel format with dedicated Setaram software. Handling is limited to the weighing and loading of the sample. The sigmometer with its associated balance, is an attractive piece of equipment for quality control. It can be readily integrated into a production line for on-line control.

Specifications

Technical data

Maximum recommended sample dimensions	Ø 30 X 20 mm
Air-gap	Ø 60 X 25 mm
Air-gap field	800 kA.m ⁻¹ / 10000 Oe ⁽¹⁾
Ejector	Electro-pneumatic jack
Sensitivity	Approx. 1 mg cobalt
Accuracy	± 1% on full scale
Measuring time	About 10 sec. (weighing excluded)
Ambient temperature range	+10°C to +40°C
Electrical Supply	230 V - 50/60 Hz - 50 VA
Air Supply	4 bars
Weight	400 kg

⁽¹⁾ 1 Oe = 1/4π kA.m⁻¹

Driving and display unit for all types

Display of σ_s in either - Gauss cm³.g⁻¹
 - Micro Tesla m³.kg⁻¹
 - cobalt content in %

by selection on the keyboard of the driving unit.

The result is given on of a 4-digit display.

Specify the type of display required when ordering. The weight of the sample is set by the keyboard with a resolution of 0.001 g up to 400.000 g. Sample form correction factor can be entered via the keyboard. Input on the rear panel for remote control.

On option

- 1) Digital input and interface to automatically feed the weight of the sample from a balance.
- 2) Digital output and interface to feed the result into the printer or computer.
- 3) Upgrading of electronic reading unit of previous Sigmameter models.

Some of our reference users

- Acerinox
- Ceratizit
- Hartmetall
- Kennametal
- Nachi
- Sandvik
- Seco
- Stellram
- Sumitomo
- Thyssen Krupp
- Toshiba Tungaloy
- Widia



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