N&H Technology GmbH

Import & Export of Industrial Products | Technical Support and Engineering | Business Consulting and Representation

Resistivity Measuring Systems

Resistance and Resistivity

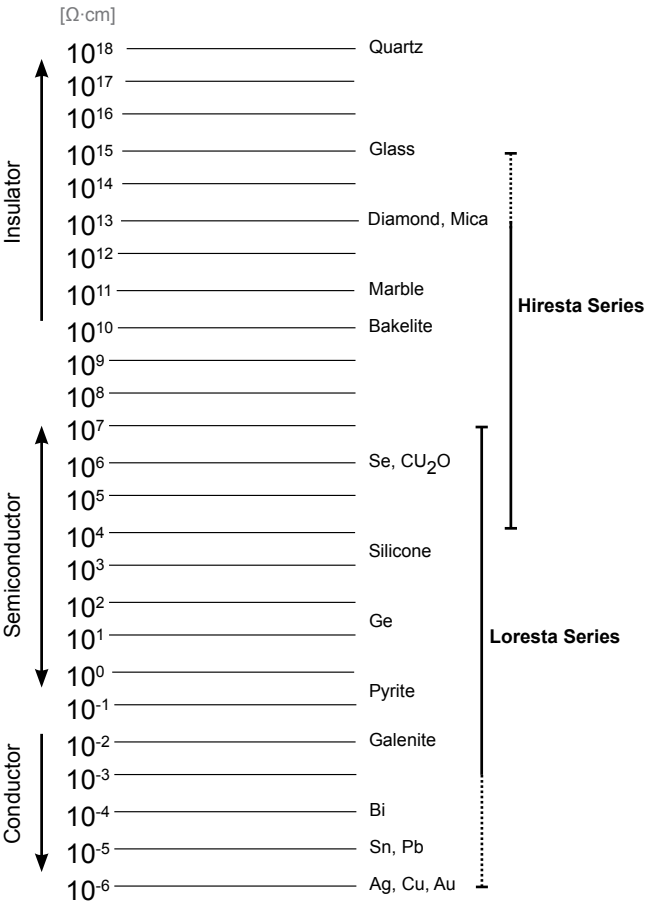
TÜVRheinland® CERT ISO 9001

Resistance and Resistivity

for a more precise material analysis

As science and technology advance, demand has increased for simple, quick and precise classification of material properties in diverse fields such as research and development, production engineering and quality control.
According to the conventional method, resistance (Ω) was used for this purpose. However, resistance does vary depending on the type, shape and size of the material and also the measuring point. Therefore, the approved measuring method uses resistivity (Ω·cm) which expresses absolute and real material values.

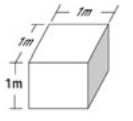
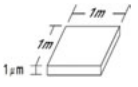
Resistivity is simply calculated by multiplying the measured resistance (Ω) with a Resistivity Correction Factor (RCF).
The resistivity measuring systems of Mitsubishi Chemical Analytech (MCCAT) have been designed to ensure easy RCF calculation and thus resistivity is measured in a simple test procedure.



Each material has a unique resistivity value.

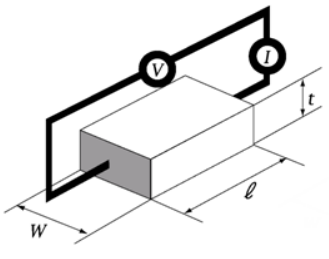
Resistivity is an absolute value

A short test proves this:

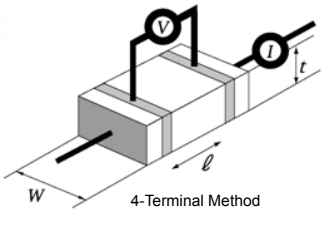
Material	Au (gold)		
Dimensions			
Resistance [Ω]	$2.4 \cdot 10^{-8}$	$2.4 \cdot 10^{-6}$	$2.4 \cdot 10^{-2}$
Resistivity [Ω·cm]	$2.4 \cdot 10^{-6}$	$2.4 \cdot 10^{-6}$	$2.4 \cdot 10^{-6}$

The results show obvious differences in resistance values, although the same test material has been used.
Therefore, resistivity is the best reliable index for material evaluation.

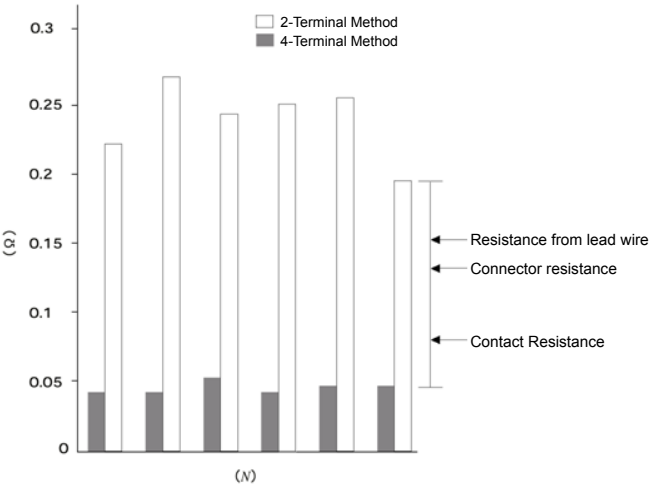
2- and 4-Terminal Method



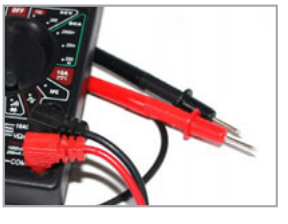
2-Terminal Method



4-Terminal Method



The 4-terminal probe of the MCCAT Measuring Systems eliminates lead-wire connector and contact resistance. More precise measuring of resistance is thus achieved.

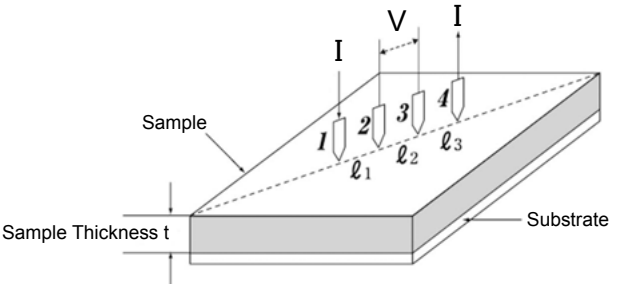


The multimeter, equipped with 2 terminals, is a cheap and simple instrument for measuring voltage, current and resistance. However, the conventional 2-terminal method is not suitable for material evaluation.

Resistance (R)

Ohm's law states that the current (I) through a conductor between two points is proportional to the potential difference (V) across the two points and inversely proportional to the resistance (R) between them.

Resistance R [Ω] = $\frac{V}{I}$ $\frac{[V]}{[A]}$



Resistivity Correction Factor (RCF)

Resistance is measured by holding a 4-pin probe against a sample surface. Volume resistivity and surface resistivity are calculated by multiplying resistance by the Resistivity Correction Factor determined by the type, shape, size and measuring point of sample. It can accurately be calculated with Poisson's Equation, a formula used in electrostatics.

Poisson's Equation

$\nabla^2 \Phi(r) = 2 \rho_v I [\delta (r-rD) - \delta(r-rA)]$

Volume Resistivity (ρ_v)

ρ_v expresses the resistance per unit volume of a sample and is also called specific resistance. Volume resistivity (Ω·cm) is the term mostly used for material classification. Each material has a unique characteristic value for volume resistivity.

Volume Resistivity ρ_v [Ω·cm] = R [Ω] · RCF · t [cm]

Surface Resistivity (ρ_s)

ρ_s is the resistance per unit surface of a sample and is also called sheet resistance. In order to distinguish this from resistance, it is written Ω/□ or Ω/sq.. Since surface resistivity varies with the sample thickness, it is often used to evaluate paint and thin films.

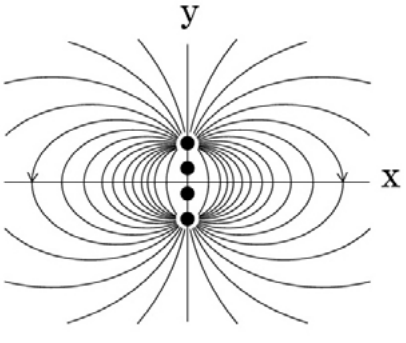
Surface Resistivity ρ_s [Ω/sq.] = R [Ω] · RCF = $\rho_v \cdot \frac{1}{t}$ t : Sample Thickness

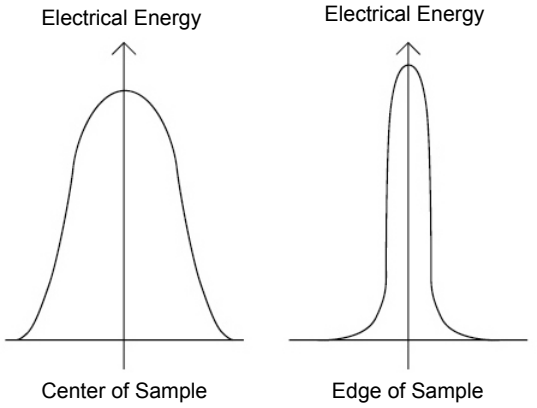
Conductivity (σ)

σ is inversely related to volume resistivity. It is also called specific conductivity. The unit is S/cm.

Conductivity σ [S/cm] = $\frac{1}{\rho_v}$

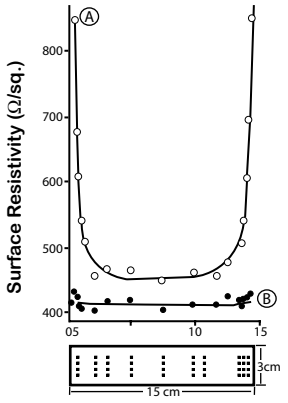
Electrical Field (4-Terminal Probe)



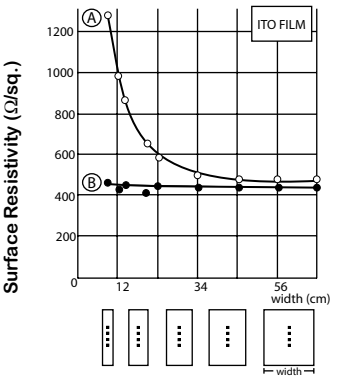


Influence of Measuring Position, Sample Size and Thickness on Resistivity

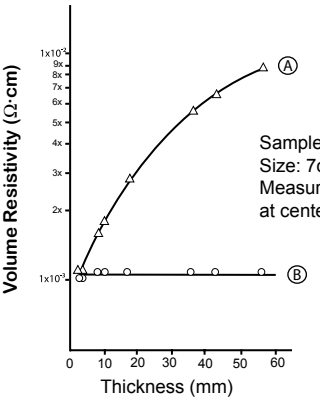
Measuring pPosition



Sample Size



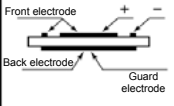
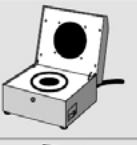
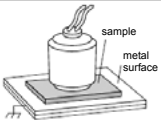
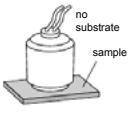
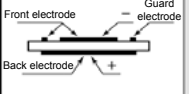
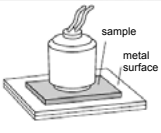
Sample Thickness



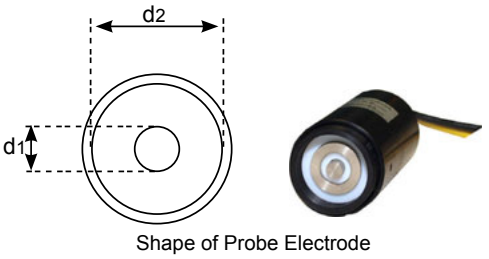
Sample: isotropic graphite
Size: 7cm x 7cm
Measured with 4-pin probe
at center of the sample

Ⓐ shows graph with constant RCF (4.532)
Ⓑ shows graph with variable RCF

Measuring Method for High Resistivity

Item	ASTM-Method (ASTM D 257)	MCC-Method (Mitsubishi Chemical Method)		
		U type JBox	Method 1	Method 2
Surface resistivity				
Volume resistivity				

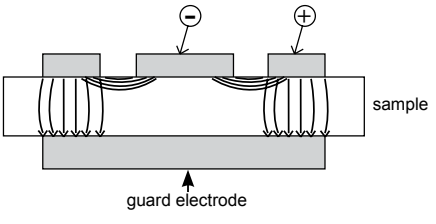
Resistivity Correction Factor



Shape of Probe Electrode

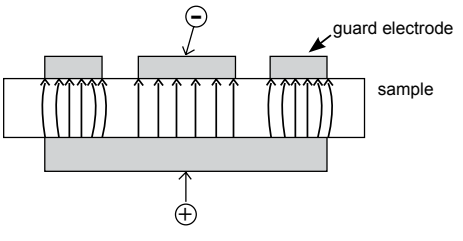
Probe	d2 (cm)	d1 (cm)	RCF_S	RCF_V
URSS	0.6	0.3	9.065	0.071
URS	1.1	0.59	10.09	0.273
UR	3.0	1.6	10.00	2.011
UR-100	5.32	5.0	100	19.63
ASTM / JIS	7.0	5.0	18.85	19.63
UA	--	--	1.050	--

Measurement of Surface Resistivity



Surface Resistivity ρ_s [Ω/sq.] = R [Ω] · RCF_S

Measurement of Volume Resistivity



Volume Resistivity ρ_v [Ω·cm] = R [Ω] · RCF_V · $\frac{1}{t}$

t : sample thickness

Hiresta-UP *MCP-HT450*

Use

R&D, Production Engineering, Quality Control

Application

Antistatic materials, flooring materials, paper, packing materials, paint, fiber, concrete, ceramics, plastics, films, etc.

Features

The Hiresta UP is specialised in measuring the resistance, the surface and volume resistivity of various substances and materials of all shapes and sizes in the high-resistance measuring range. A 5.7" LCD is for easy reading of data. Optionally the data transfer to PC is possible through a RS232C port. The probe is designed to read fast and accurately with one touch. With an increased supply voltage of max. 1000V on the probe, the Hiresta-UP ensures diverse applications. It is also compact and user-friendly.

Specifications

Measuring method	Ring probe, constant-voltage method								
Measurement range [Ω]	10^4	10^5	10^6	10^7	10^8	10^9	10^{10}	10^{11}	10^{12}	10^{13}
Supplied voltage	10V / 100V / 250V								500V / 1000V	
Measuring accuracy	± 2.0%							± 3.0%	± 4.0%	± 5.0%
Display	5.7" LCD, 320 x 240 pixel									
Power supply	AC 85-264V / 47-63Hz / 92VA									
Comparator	minimal and maximal settings, manually									
Period of memory backup	Approx. 3 years (uses lithium battery)									
Electric shock protection	A foot switch controls the connection to the probe									
Ring probe types	URS, UR, UR-SS, UR100, U-type J-Box									
Interface of data output	RS232C									
Dimensions	330mm x 270mm x 88mm (W x D x H)									
Weight	3,4 kg									
Standard accessories	URS probe (Ring probe, inner-ring Ø 0.59cm, outer-ring Ø 1.1cm) probe checker (500 MΩ)									

Standard Accessories

URS Probe
RMH214

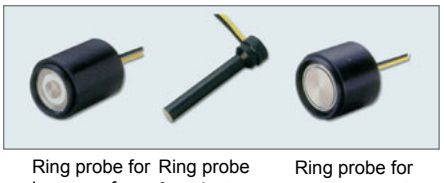
Probe Checker
RMH327

A probe checker controls the probe before measuring

To measure just hold the probe perpendicularly to the sample

Switching from ρ_s to ρ_v is possible with the U-type switch box (RMJ352)

Optional Probes

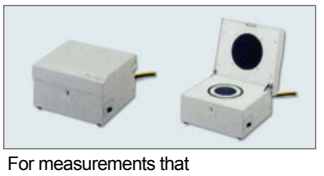


Ring probe for larger surfaces
RMH212

Ring probe for minute samples
RMH215

Ring probe for measurements up to 10^{15} Ω/sq.
RMH216

2-Pin probes for thin and long samples. Distance between pins: 20.00mm, pin Ø 2mm, spring pressure 240g/pin.
RMH211



For measurements that conform with ASTM D 257.
U-type J-Box
RMJ350

Loresta-GP *MCP-T610*

Use

R&D, Production Engineering, Quality Control

Application

Conductive materials: Paint, paste, plastics, rubber, films, fiber, ceramics, metallic thin films, amorphous silicone, anti-static materials, EMI-shield materials, etc.

Features

The Loresta-GP has a wide measuring range from 10mΩ to 10MΩ with 4-digital accuracy and 18 measurir range settings. The 4-pin probe ensures quick and precise resistivity measurements. A 5.7" LCD is for eas reading of data. Optionally the data transfer to PC is possible through a RS232C port. The probe enables one-touch direct reading of [Ω], [Ω/sq.], and [Ω·cm]. The data storage is for 1000 readings.

Specifications

Measuring method	4-pin probe, constant-current method										
Measurement range [Ω]	10^{-3}	10^{-2}	10^{-1}	10^{0}	10^{1}	10^{2}	10^{3}	10^{4}	10^{5}	10^{6}	10^{7}
Supplied current	100mA			10mA		1mA	100µA	10µA	1µA	0.1µA	
Measuring accuracy	± 2.0% ± 20dgt.	± 1.0% ± 5dgt.	± 1.0% ± 3dgt.	± 0.5% ± 3dgt.						± 1.0% ± 3dgt.	± 2.0% ± 5dgt.
Display	5.7" LCD, 320 x 240 pixel										
Power supply	AC 85-264V / 47-63Hz / 92VA										
Comparator	minimal and maximal settings, manually										
Period of memory backup	Approx. 3 years (uses lithium battery)										
Sample protection	Based on voltage limiter. The voltage at the open terminal is limited from approx. 10V to approx. 90V. The measuring stops when the voltage is approx. 90V.										
4-pin probe types	ASP, ESP, LSP, PSP, BSP, QPP, TFP, AP, BP										
Interface of data output	RS232C										
Dimensions	330mm x 270mm x 88mm (W x D x H)										
Weight	3,4 kg										
Standard accessories	ASP probe (4-pin probe, inter-pin distance 5mm, pin-head radius 0.37mm) Probe checker (1.0Ω)										

dgt.=digits

Standard Accessories for Loresta-GP and Loresta-AX

ASP Probe
RMH110

Probe Checker
RMH304

The probe checker controls the probe before measuring

The probe has to be placed perpendicular to the sample

Optional Probes for Loresta-GP and Loresta-AX

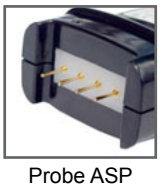
Probe TFP

Probe BSP

Probe PSP

Probe QPP

Probe ESP



Probe ASP

Loresta-AX *MCP-T370*

Use

R&D, Production Engineering, Quality Control

Application

Conductive materials: Paint, paste, plastics, rubber, films, fiber, ceramics, metallic thin films, amorphous silicone, anti-static materials, EMI-shield materials, etc.
Plating thickness measurements of plated materials

Features

The Loresta-AX has a wide measuring range from 10mΩ to 10MΩ. The 4-pin probe ensures quick and precise resistivity measurements. A LC Dispaly is for easy reading of data. Data saved can be transmitted via USB-memorystick.
The probe enables one-touch direct reading of [Ω], [Ω/sq.] and [Ω·cm].

Spezifications

Measuring method	4-pin probe, constant-current method								
Measurement range [Ω]	10^{-2}	10^{-1}	10^{0}	10^{1}	10^{2}	10^{3}	10^{4}	10^{5}	10^{6}
Supplied voltage	100mA		10mA		1mA		100µA	10µA	1µA
Measuring accuracy	± 1.0% ± 20dgt.	± 1.0% ± 5dgt.	± 0.5% ± 5dgt.	± 0.5% ± 3dgt.					± 2.0% ± 5dgt.
Display	LCD								
Power supply	AC 90-264V / 47-63Hz / Nickel-Hydrogen Battery								
4-Pin probe types	ASP, ESP, LSP, PSP, BSP, QPP, TFP, AP, BP								
Data output	USB-Memorystick								
Dimensions	85mm x 228mm x 65mm (W x D x H)								
Weight	420 g								
Standard accessories	ASP probe (4-pin probe, inter-pin distance 5mm, pin-head radius 0.37mm) Probe checker (1.0Ω)								

Probe	**ESP**	**LSP**	**TFP**	**QPP**	**PSP**	**BSP**	**AP**	**BP**
Application	non-uniform samples	soft surfaces	thin films	smallest samples	small samples	large samples	thin films on metal alloy	thin films on non-uniform samples
Inter-pin distance	5 mm	5 mm	1.0 mm	1.5 mm	1.5 mm	2.2 mm	10mm	frei
Pin-head radius	Pin Ø2mm	Pin Ø2mm	0.15mm	0.26mm	0.26mm	0.37mm	Pin Ø2mm	Pin Ø2mm
Spring Pressure	240 g/pin	130 g/pin	50 g/pin	70 g/pin	70 g/pin	210 g/pin	240g/pin	240g/pin
Order no.	RMH114	RMH116	RMJ217	RMH115	RMH112	RMH111	RHM117	RMH118
Probe checker	RMH304	RMH304	RMH 312		RMH311		RMH302	RMH302

Probes: ASP, ESP, TFP, QPP, PSP and BSP

Powder Resistivity Measuring System

Consisting of the main powder measuring unit and the Loresta-GP or Hiresta-UP measuring unit.

Use

Research & Development, Quality Control, etc.

Application

Powder materials of carbon products:
Materials used for rechargeable battery electrodes, condensers and resistance material and insulating electronics / cokes / graphite / carbon black / carbon fiber / nano carbon, etc.

Metal powder:
Materials used for battery electrodes, thin film materials such as copper powder or ITO powder, for circuit board materials, for example conductive paste and electro conductive paint.

Others:
Printer toner, magnetic material such as ferrite, food material, pharmaceutical related and automobile parts.

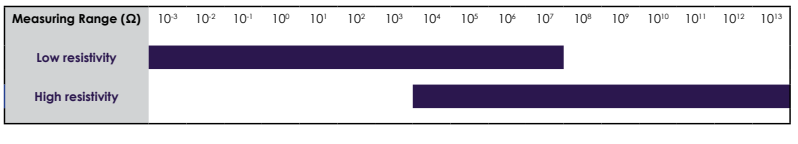
Features

The MCP-PD51 contains a high precision pressure gauge for the measurement of conductive powders for maximum pressure of 20kN and is quickly attached to either the Loresta-GP or Hiresta-UP unit.

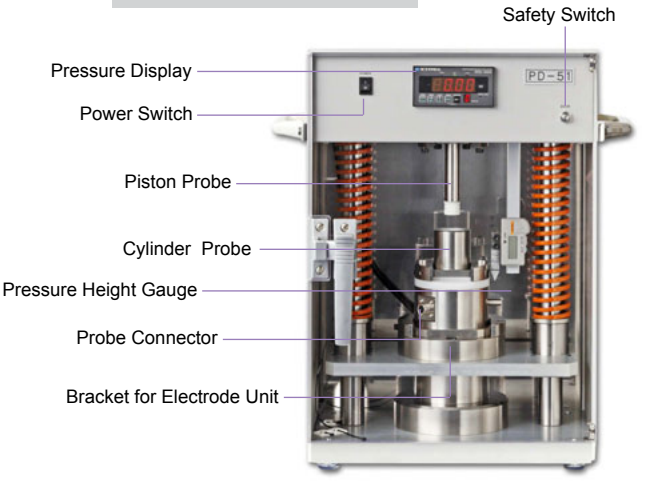
- Easy sample change and cleaning
- 4-pin probe for precise measurement of low range resistivity
- Ring probe for high range resistivity
- Powder is pressed in a cylindrical shape for measuring

Specifications

Measuring method	Constant-current / -voltage methods
Measuring Units	Low resistance (10^{-3}-10^{7} Ω) Loresta-GP High resistance (10^{4}-10^{13} Ω) Hiresta-UP
Power supply	AC 90 - 240V / 50 - 60Hz
Max. load to the power unit	20kN (ca. 60MPa)
Hydraulic unit	Oil pressure (manual operation)
Probe unit	20mm (Ø) x 50mm (L)
Probe types	4-pin electrode (inner-pin distance 3mm) Ring electrode (Ø 20mm)
Dimensions	430mm x 230mm x 490mm (W x D x H)
Weight	Main unit 56kg, Hydraulic unit 22kg
Necessary accessories	Analysis software for test reports



Main Unit

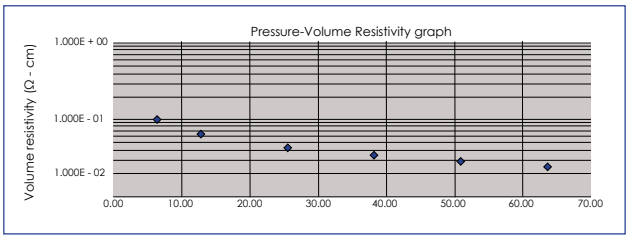


Measuring Electrodes

For Low Resistivity Measurement (Electrode for 4 Terminal Method) MCP-PD511

For High Resistivity Measurement (Ring Electrode) MCP-PD522

Test Report



Sample			Carbon black						
No.	Load (kN)	Pressure (MPa)	Thickness (mm)	RCF	Resistance (Ω)		Volume resistivity (Ω -cm)	Conductivity (S/cm)	Density (g/cc)
1	2.00	6.37	4.95	2.833	OK	7.078E-02	9.926E-02	1.007E+01	6.431E-01
2	4.00	12.73	4.15	3.110	OK	5.132E-02	6.624E-02	1.510E+01	7.670E-01
3	8.00	25.46	3.46	3.349	OK	3.788E-02	4.389E-02	2.278E+01	9.200E-01
4	12.00	38.20	3.10	3.463	OK	3.206E-02	3.442E-02	2.906E+01	1.027E+00
5	16.00	50.93	2.86	3.533	OK	2.860E-02	2.890E-02	3.460E+01	1.113E+00
6	20.00	63.66	2.64	3.590	OK	2.570E-02	2.436E-02	4.106E+01	1.206E+00

N&H Technology GmbH

Since N&H Technology GmbH was founded in 2001, we have been importing and exporting a wide range of industrial products and serving our customers with respective technical support and advice.

As a System-supplier with own technical know-how, we focus on providing our customers with optimized comprehensive input-systems and assembly.

We are the link between manufacturing plants in Asia and customers in Europe. At N&H Technology German and Chinese engineers work as a team to ensure optimal communication with customers and manufacturers - even in complex technical issues.

We cooperate with and represent in Europe many technically-specialised companies from various industries.

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We not only represent numerous leading and technically-specialized companies in Asia but also these listed manufacturers found in German-speaking countries, and in some cases with exclusive rights.

Skyray Instrument

XRF-Spectrometer for

- Element analysis
- Analysis by RoHS/WEEE
- Alloy analysis
- Layer thicknesses analysis

HAN'S LASER

Lasersystems for

- Laser-Marking
- Laser-Cutting
- Laser-Welder
- Laser-Show-System
- Sub-Surface Engraver

MITSUBISHI CHEMICAL ANALYTECH

Measuring Devices for

- Surface Resistivity
- Volume Resistivity
- Powder Resistivity

N&H Laboratory

We carry out tests and analysis on site at Willich

- Conductivity, Resistivity and Volume Resistivity of materials and surfaces
- Resistivity of powders
- Element analysis with XRF Spectrometers
- Laser cutting, engraving and marking of small series production
- Force-travel performance of control units
- Life and durability of control units
- Abrasion resistance of coated and printed surfaces
- Light density, colour coordination and dominant wave lengths, brightness control (homogeneity) of displays, backlights, backlit keyboards and pictograms, etc.
- Climate Tests (temperature and humidity)

Services

- Presentation and demonstration of diverse machinery, equipment and measuring systems at N&H in Willich, Germany
- We analyse samples and finish prototypes at short notice
- Individual and low-cost solutions provided on-site
- Installation of systems and machinery with On-Site Training
- Maintenance and Service contracts (optional)
- Technical Advice and Consultation
- 24h Service

For individual demonstrations and technical advice please contact:
+49 (0)2154 - 8125-0