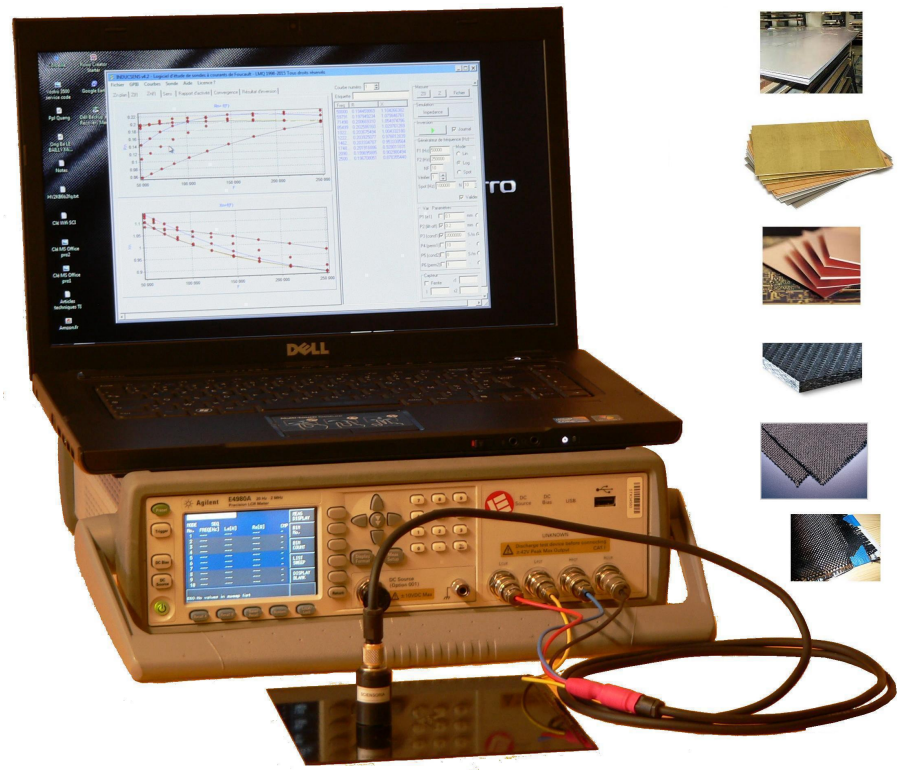
CONDUCSENS™



Titan

Aluminium

Copper

Graphite

Carbon fiber composite materials (CFRP)

CONDUCSENS™ is composed of an impedance analyzer, a special eddy current probe and, the most important thing, an analysis software running under Windows XP, 7, 8™

OPERATING PRINCIPLE

The non-contact, electrical conductivity measurement system Conducsens™ works following the eddy current principle: the probe emits a high frequency magnetic field which generates eddy currents in a conductive target. These currents create in their turn a secondary magnetic field which can be sensed by the same probe. By analyzing the secondary field, a computer program determines parameters that are related to eddy currents: lift-off, thickness, electrical conductivity, magnetic permeability of the target.

The eddy current method allows to measure the electrical conductivity of a material even when the probe does not touch the material: measurement can be made through a non conductive coating. When the material is a blend of conductive and non conductive material like carbon composite, the only method for measuring of electrical conductivity is eddy current method.

FEATURES

- Very wide range of conductivity: from 10,000 S/m (100 µΩm) to 70,000,000 S/m (0,014 µΩm) without calibration (the most conductive metal is silver with σ=63,000,000 S/m).
- Measures the electrical conductivity of carbon fiber composite materials
- Measures the electrical conductivity of thin sheets
- Measures the electrical conductivity of ferrous metals.
- Wide range of lift-off compensation. Lift-off is not only compensated but also measured.

SCIENSORIA sarl 35170 BRUZ France - phone: 33 2 99 57 19 71 fax: 33 2 99 57 18 78
email : info@sciensoria.fr Web site : www.dtktor.com

TECHNICAL SPECIFICATIONS

Probe excitation

- Variable frequency in the range of 500 Hz – 250 kHz with 1 Hz resolution selectable by the software
- Up to 50 frequencies can be utilized for one conductivity measurement

Probe diameter

- Probe for carbon fiber composite materials: 16 mm (sensing element)
- Probe for metals: 10 mm (sensing element)

Measurement range

- from 10,000 S/m (100 µΩm) to 70,000,000 S/m (0,014 µΩm)

Target thickness effect

Conducsens™ excites the probe with a variable frequency ***f*** ranging from f_{min} to f_{max}.

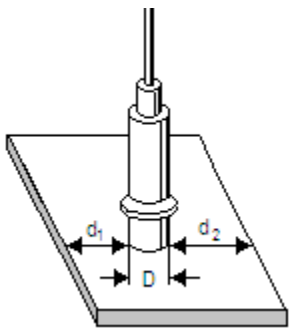
- *Thickness > Skin depth max:* target thickness is greater than the greatest skin depth (with $f_{min} \leq f \leq f_{max}$) has no effect on the measurement. In this case, the magnetic field can not reach the other side of the target.
- *Skin depth min ≤ Thickness ≤ Skin depth max*: targets with thickness smaller than the greatest skin depth but greater than the smallest skin depth on the entire frequency range can be measured simultaneously with the conductivity. In this case, the magnetic field can reach the other side of the target, at least at the lowest excitation frequency.
- *Thickness < Skin depth min:* target thickness smaller than the smallest skin depth (on the frequency range) must be entered as input parameter to the analysis program. This is the case of very thin targets.

Target size requirements

The distance between the probe and any edge of the target must be equal or greater the probe diameter

$d_1 \geq D$

$d_2 \geq D$



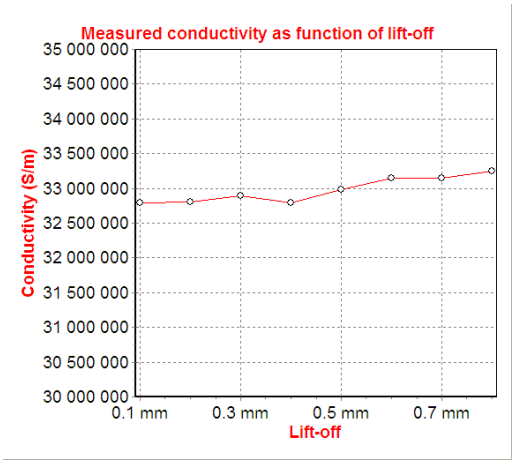
Target material requirements

- **Non magnetic materials:** any conductive material (carbon graphite, metals, carbon composites).
- **Magnetic materials:**
  - low magnetic material (stainless steels): conductivity can be measured simultaneously with relative permeability
  - high magnetic material like cast irons can be measured with external saturation magnetic field in order to reduce the non linearity of the material

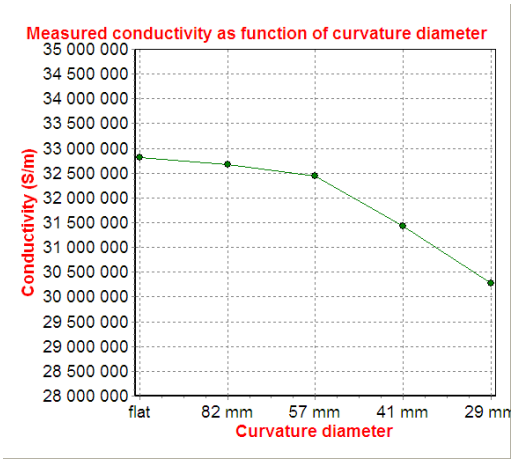
SCIENSORIA sarl 35170 BRUZ France - phone: 33 2 99 57 19 71 fax: 33 2 99 57 18 78
email : info@sciensoria.fr Web site : www.dtktor.com

Lift-off and curvature effects

The specifications below are given for the “metals” standard probes (10 mm diameter). The target is a thin aluminum sheet (13 µm thickness). Its conductivity measured with a 4-contacts method is 33 MS/m.



Effect of increasing lift-off on conductivity reading



Effect of increasing curvature on conductivity reading

Calibration

No calibration required.

Measurement time

Measurement time depends on the impedance meter model. The values below are given for the HP4192A from Agilent. Recent models are much faster.

- Typical rate: 10 seconds per measurement in multi-frequency mode
- High rate: 0.1 second per measurement in single frequency mode

Operating temperature

0° to 40°C. Temperature effect should be corrected afterward.

Warranty

1 year, excluding probe and cable (6 months). Incorrect uses are not covered by the warranty.

Compatible impedance meters

Agilent E4980A, Agilent 4284A™, Agilent 4192A™, IET Lab 1920™ LCR meter

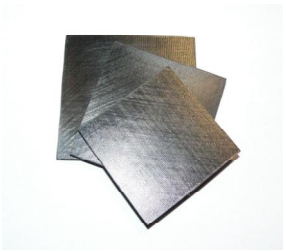
SCIENSORIA sarl 35170 BRUZ France - phone: 33 2 99 57 19 71 fax: 33 2 99 57 18 78
email : info@sciensoria.fr Web site : www.dtktor.com

SAMPLE APPLICATIONS

A. Measurement of electrical conductivity of carbon fiber material (CFRP)

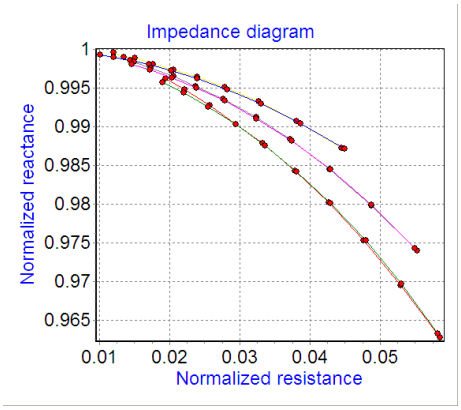
A carbon composite material is composed of carbon fiber and epoxy resin. The fibers are not always in contact, so it is difficult to use the classical 4-points method for determine the electrical conductivity of the material. Eddy current method allows to induce electric currents inside the fibers, thus solving the problem. Measuring speed is of the order of several seconds.

The 3 composite material samples at the right have been made by a same process but have 3 different thickness: 2.6 mm, 5 mm and 10 mm. The aim of the experiment is to measure their electrical conductivity.



CONDUCSENS™ gives:

- for 2.6 mm plate, estimated conductivity is 14,667 S/m
- for 5 mm plate, estimated conductivity is 14,685 S/m
- for 10 mm plate, estimated conductivity is 14,810 S/m



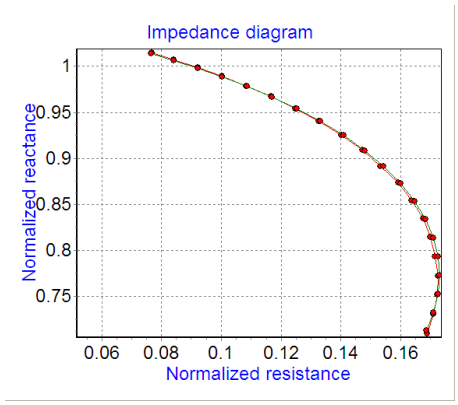
The impedance diagrams at the right show a good matching between acquired data and simulated data using a numerical model. Note that the 3 different plates yield 3 different curves, but the estimated conductivities are nearly the same. This is obviously logical considering that the plates have been made by a same process.

B. Measurement of electrical conductivity of a magnetic stainless steel (z3cn18/10)

The electrical conductivity of a cylinder of stainless steel was measured. The metal reference is z3cn18/10. Impedance measurements show that the metal is ferromagnetic, so *relative permeability research option* has been activated.

Conducsens™ gives:

- Estimated lift-off: 0.01 mm
- Estimated conductivity: 1,546,476 S/m
- Estimated relative permeability: 1.20



The figure at the right side shows a good matching between acquired data and simulated data using a numerical model.

C. Other sample applications

Please check the Web site www.dtktor.com for more application notes.

COMMERCIAL CONTACT

SCIENSORIA sarl 35170 BRUZ France - phone: 33 2 99 57 19 71 fax: 33 2 99 57 18 78
email : info@sciensoria.fr Web site : www.dtktor.com