Voltage-dependent resistance measurement!

With the new „Resistance-Break-Down“ recording

TERA-Ohmmeter TOM 610 from Kleinwaechter GmbH

An ohmic resistance is independent of the measuring voltage.
With the well-known measuring devices such as TERA-Ohmmeter, stable measuring voltages of 10, 100, 250, 500 and 1000 V are common.

A pure "ohmic resistance" is independent of the voltage, the current flowing through it and the frequency.
A straight line through the origin is obtained by creating a line diagram where the voltage is plotted against the current.
In the case of frequency independence, the resistance must not cause a phase shift between the measuring voltage and the measuring current.

Important! If the measurement currents are too high, the resistor converts the electrical energy into thermal energy, which in turn can influence the measurement result.

Therefore, the measurement voltages in a Tera-ohmmeter are all current-limited.
Not pure Ohmic resistances “such as long wires, coils, capacitors and rectifiers (diodes, semiconductors etc.)” cannot be calculated with the“ Ohm’s law U = I x R.

In the most marginal measuring range, it is the plastics that are mixed with non-electrically chargeable (conductive) additives in order to be able to carry them as sales products under non-chargeable plastics.
Plastics with "non-chargeable additives" have an electrical resistance range of 10^3 ohms up to $<10^{12}$ ohms.

These additives must be incorporated into a high-resistance plastic with a homogeneous distribution.

In Fig. 1 and Fig. 2 two raster images can be seen in black and white.

Fig. 1 shows a non-chargeable additive substance in a non-homogeneous distribution.

Fig. 2 shows the same non-chargeable substance in a homogeneous distribution.

Example: The requirement for a non-chargeable plastic was that the surface and volume resistance at any point must not exceed 10^5 ohms. Ö

The first containers were injection molded with the plastic according to Fig. 1 and at 1000 V measurement voltage a resistance value of 10^5 ohms was measured.
By a measurement voltage of 100 V, a value of 10^9 Ohm was measured.
Then the measuring voltage of 1000 V was left at the same measuring point for 10 minutes and then a measured value > 10^{10} ohm was measured.

In Fig. 2 you can see that the additive is distributed homogeneously in the high-resistance plastic compound.
These resistance values were by a measuring voltage of 100V at max. 10^5 ohms in the required range.
Now the question is, which measuring voltage the right one is?
Answer: "The measuring voltage of 100V".
Now it is interesting how the voltage-dependent resistance runs.

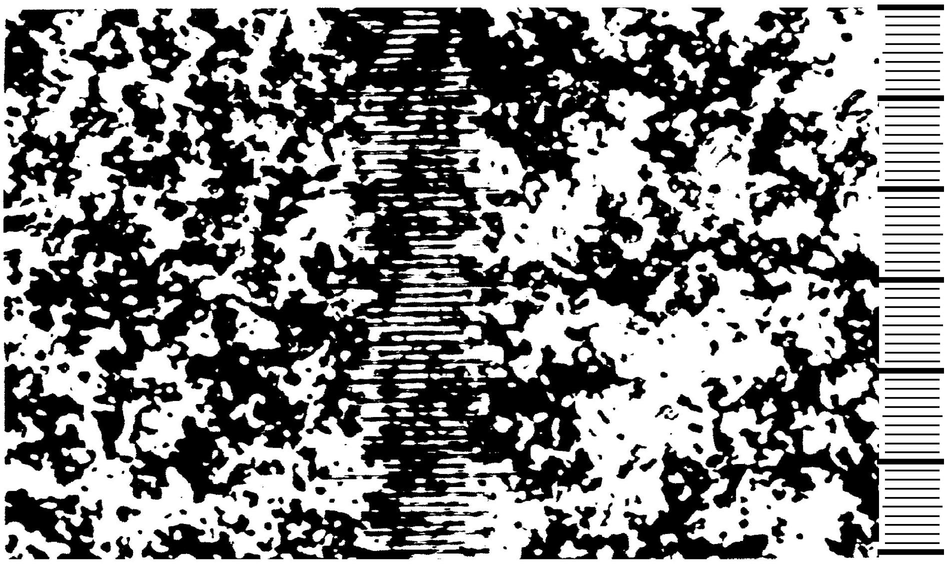
This voltage dependency can be made visible by a linear voltage measurement curve in that the measurement voltage increases in 50V steps from 100V and the resistance behavior is saved in steps.
If a breakdown occurs after a certain measurement voltage value (sudden drop in resistance value), this measurement voltage and the resistance value before and after the breakdown will be saved and displayed.
The current market only offers TERA ohmmeters with permanently selectable measurement voltages of 10, 100, 250, 500 and 1000 V.

The EN standards prescribe a constant climate as well as a certain measuring time and recommend measuring voltage values. Unfortunately, the measurement voltage behavior (voltage dependency) of the plastics or test objects is not taken into account in the EN standards.

With the new Kleinwaechter TOM 610 tera-ohmmeter, the voltage-dependent resistance value can be recorded with the break-down value of the measurement voltage and resistance value. The maximum and minimum break-down resistance values are also saved and displayed.

Fig.1

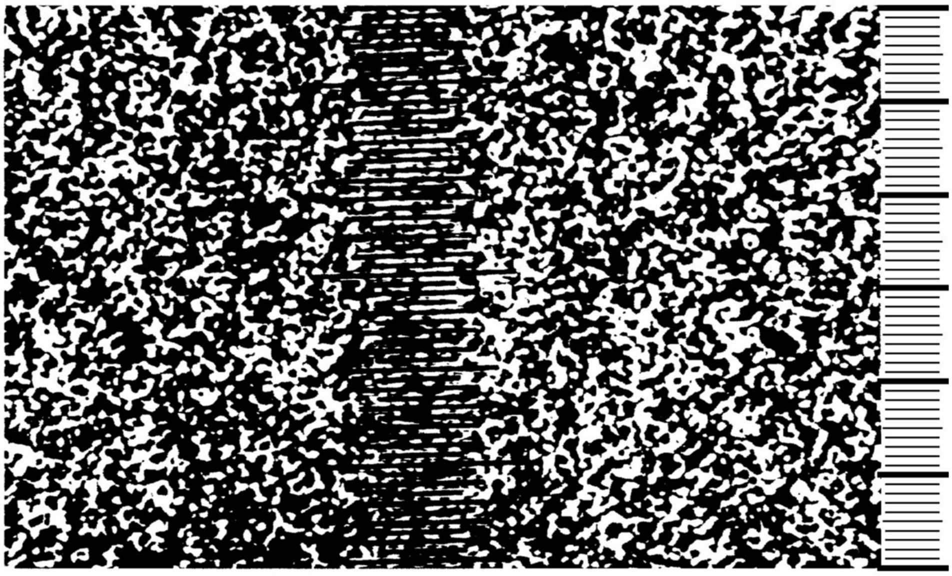
Homogenitätsverteilung leitfähiger Substanzen in nichtleitender Masse



Materialstruktur mit schlechter Vermischung

Fig.2

Homogenitätsverteilung leitfähiger Substanzen in nichtleitender Masse



Materialstruktur mit guter Vermischung

From Fig.1 compared to Fig.2 it is easy to see that a non-homogeneous introduction of non-chargeable additives causes a voltage dependency of the test object!

A scale of the ordinate (Y-axis) from step to step of 1 µm is shown on the right-hand side. The distances between the non-chargeable additives are differently small and large. An electrical field builds up in between. If the breakdown field strength is exceeded, a glow discharge can occur in between, and the resistance can suddenly decrease as long as the measuring voltage is present. This situation can occur suddenly and initiate the resistance breakdown.

Now there are two situations which depend on the type of additive. Due to the fine filigree ramifications of the non-chargeable additive, a carbon bridge can form through the glow discharge, so that the resistance of the test object remains low due to the resistance breakdown or that the filigree non-chargeable additives such as a fine wire fuse burn through and through the break-down resistance of the test object becomes higher.

Summary:
The voltage-dependent resistance breakdown cannot be determined by means of fixed, predetermined measuring voltages. For the first time it is possible with the new tera-ohm meter type TOM 610 from Kleinwaechter GmbH to display, record and save this value.
It can also be seen whether or not the non-chargeable additives were introduced homogeneously mixed. If the measured value remains below 50% as a function of the measuring voltage ramp from 100 V to 1000 V, it can be assumed that the additive admixture is homogeneously distributed in the high-resistance plastic and that this value does not change significantly as a function of time will change.

Comment:
Unfortunately, the responsible standards committee has not yet published a public, tangible standard on the voltage dependence of resistance measurements in plastics. The users had to be satisfied with a wide variety of resistance measurement results and inconsistent, reproducible comparison measurements.
The complaints received by Kleinwaechter GmbH have led to the development of a new tera-ohmmeter to alleviate these measurement problems for semiconducting and conductive plastics.

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Hermann Künzig

(translation from the German Original by Kleinwaechter GmbH)