MEASURING MULTIPLE LAYERS

Eddy current instruments cannot focus on specific layers

An eddy current instrument cannot be modified or “focused” to read the sheet resistance of only one layer. Therefore—strictly speaking—if there is more than one conductive layer present, the value of an individual conductive layer cannot be read. However, if the user is able to take multiple readings throughout the manufacturing process, a Delcom meter can be used to determine the individual values of multiple conductive layers.

Superposition

Delcom meters measure all the material presented to the sensor. If a material has multiple conductive layers, the meter will return a reading representing the sum of the conductance of those layers. This feature of a Delcom meter is called superposition.

If the user thinks in terms of sheet conductance (as opposed to sheet resistance), superposition is easy to understand:

$$Sheet\ conductance\ of\ entire\ stack\ of\ X\ number\ of\ layers\ = A + B + C + \cdots + X$$

If the user is thinking in terms of sheet resistance, the equation is:

$$Sheet\ resistance\ of\ entire\ stack\ of\ X\ number\ of\ layers\ = \frac{1}{(\frac{1}{A} + \frac{1}{B} + \frac{1}{C} + \cdots + \frac{1}{X})}$$

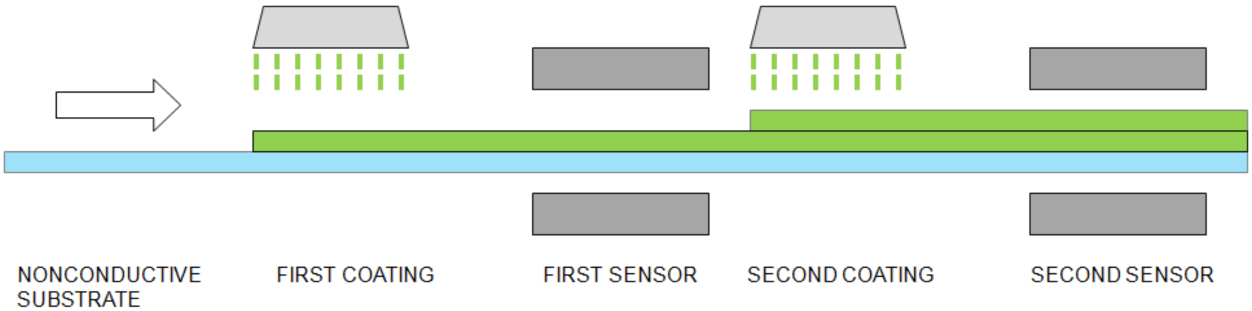
We will conduct this discussion in terms of sheet conductance.

Measuring multiple layers

In order to read individual multiple layers, the user must read the first conductive layer, then coat the material again and take a second reading. The conductance of the second layer can be inferred by subtracting the value of the first reading from the value of the second reading.

In a benchtop setting, the user simply needs to measure the material after the first coating, coat the material again, and then measure the material a second time.

In an inline setting, this process can easily be accomplished by placing one sensor before the second coating process and a second sensor after the second coating process.



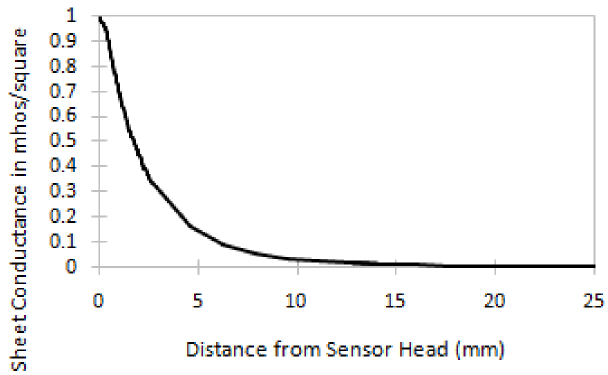
However, for a production process which coats an entire batch and then coats the entire batch a second time, it may be necessary to assume an average value for the entire first coating and subtract this one value as a new baseline for the second coating. Delcom software has a feature called Zero Offset that allows the user to input this one value, after which all subsequent displayed readings will be the actual reading minus this offset.

A further refinement of this method of reading multiple layers would be to actually physically encode the material for better subtraction of the value of the second coating.

Measuring multiple layers separated by significant distances

The concepts discussed in this section apply to both single-sided sensor meters and meters with a top and bottom sensor. However, the effects are most pronounced for single-sided sensors, so this discussion will focus on single-sided sensors.

Graph 1 illustrates the lift-off effect that occurs with single-sided sensors (see Delcom_KC8_Lift-Off Effect for S3 Sensor). In this example, a 1.0 mho/square sample reads 1.0 mhos/square when the sample is intimate with the face of the sensor. As the sample is moved away from the face of the sensor, the displayed value of the sample in ohms/square decreases. For this example, at 5 mm away from the face of the sensor, the meter will read the sample as approximately 0.1 mhos/square.



Graph 1: S3 lift-off

Now imagine a user is measuring a sample that consists of two 1.0 mho/square layers separated by 5 mm of nonconductive material. If this sample is placed intimate with the face of the single sided sensor, it will read 1.1 mhos/square. If the sample is flipped, the reading will be the same.

For this example, in order to get an accurate reading of both layers, the following is required of the user:

1. Know the thickness of the nonconductive layer
2. Know the coefficient of distance at the thickness of the nonconductive layer (in this example the coefficient is 10)
3. Coat the first side and make a reading
4. Coat the second side and make a reading
5. Subtract the difference between the two readings, multiply the difference by the coefficient of distance (in this example, 10), and the user will have arrived at the value of the second layer

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