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Use Van der Pauw Method to Measure Worksurface Resistance

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Objectives

1. Assumption: Not take into account impact of humidity.
2. Electrostatic dissipative worksurface is widely used in EPA. Normal way to check the resistance of worksurface: SRM connected to five-pound probes [1]. This method is localized and may not represent overall resistance property which can be found through Van der Pauw Method.
3. Using current source instead of voltage source.
4. Managed to relax the constraints of the standard procedure.

   – To check the overall resistance of worksurface

Outline

1. Measuring Equipment & Sample

2. Procedure

3. Calculation

4. Illustration

5. Discussion & Conclusion

1. Measuring Equipment & Sample
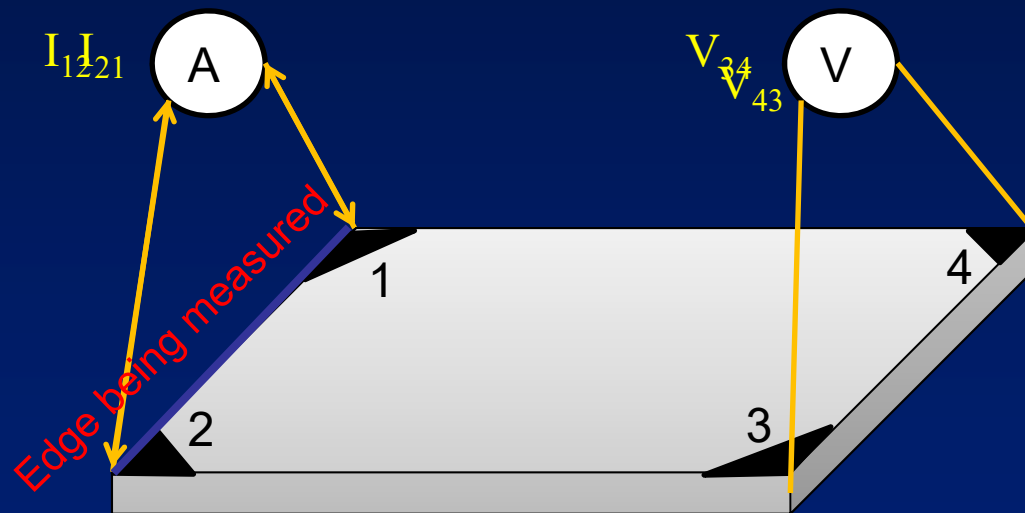
- Equipment
  - Current source
  - Voltage meter

- Sample
  - No isolated holes.
  - Homogeneous (worksurface can be treated as homogenous)
  - Two-dimensional sample (thin and wide) [2]

2. Procedure

$I_{12}I_{21}$ $V_{34}V_{43}$

Edge being measured

1   2   3   4

$R_{12,34}=$ ——— $R_{12,34}=$ ———

•Repeat the procedures for the rest 3 edges

3. Calculation

Vertical Resistance:

$$R_{12,34} = \frac{V_{34}}{I_{12}} \quad R_{34,12} = \frac{V_{12}}{I_{34}} \quad R_{21.43} = \frac{V_{43}}{I_{21}} \quad R_{43,21} = \frac{V_{43}}{I_{21}} \tag{1}$$

Horizontal Resistance:

$$R_{23,41} = \frac{V_{41}}{I_{23}} \quad R_{41,23} = \frac{V_{41}}{I_{23}} \quad R_{32,14} = \frac{V_{14}}{I_{32}} \quad R_{14,32} = \frac{V_{32}}{I_{14}} \tag{2}$$

Resistance From Vertical Edge:

$$R_{vertical} = \frac{V_{12,34} + V_{34,12} + V_{21,43} + V_{43,21}}{4} \tag{7}$$
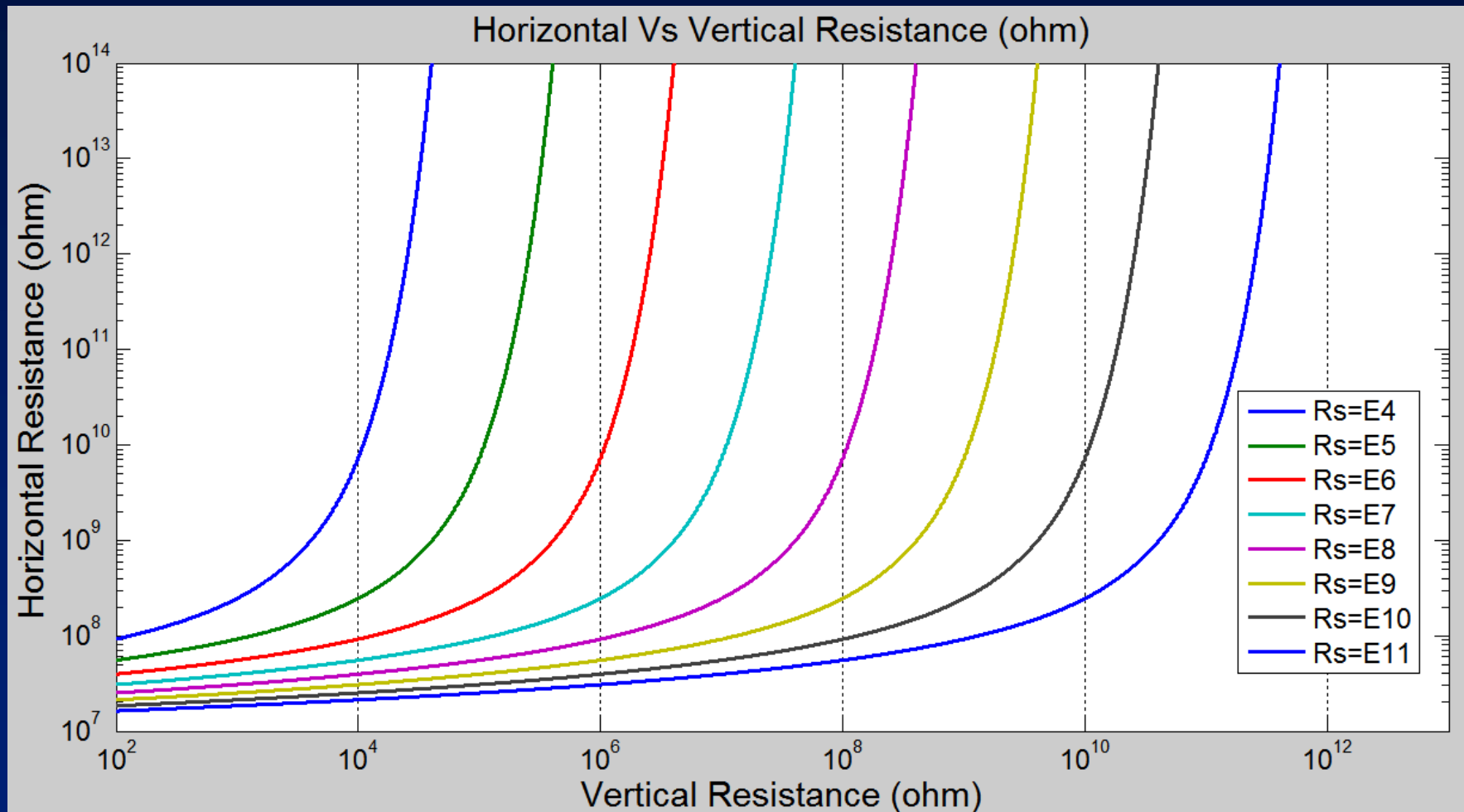
Resistance From Horizontal Edge:

$$R_{honrizontal} = \frac{V_{23,41} + V_{41,23} + V_{32,14} + V_{14,32}}{4} \tag{8}$$

Van der Pauw Formula:

$$e^{-\pi R_{vertical}/R_S} + e^{-\pi R_{honrizontal}/R_S} = 1 \tag{9}$$

4. Illustration

Characteristics of horizontal & vertical resistance for static dissipative planar material resistance ($10^4 <= R_s < 10^{11}$ ohm)

5. Conclusion & Discussion

- By using Van Der Pauw method, overall worksurface resistance can be found. This method can be used for evaluating and selecting worksurface materials, testing of new worksurface installations, and the testing of previously installed worksurfaces.

- resistivity of a certain material can be determined in samples of arbitrary shape without knowing the current pattern.

- Overall resistance (not localized).
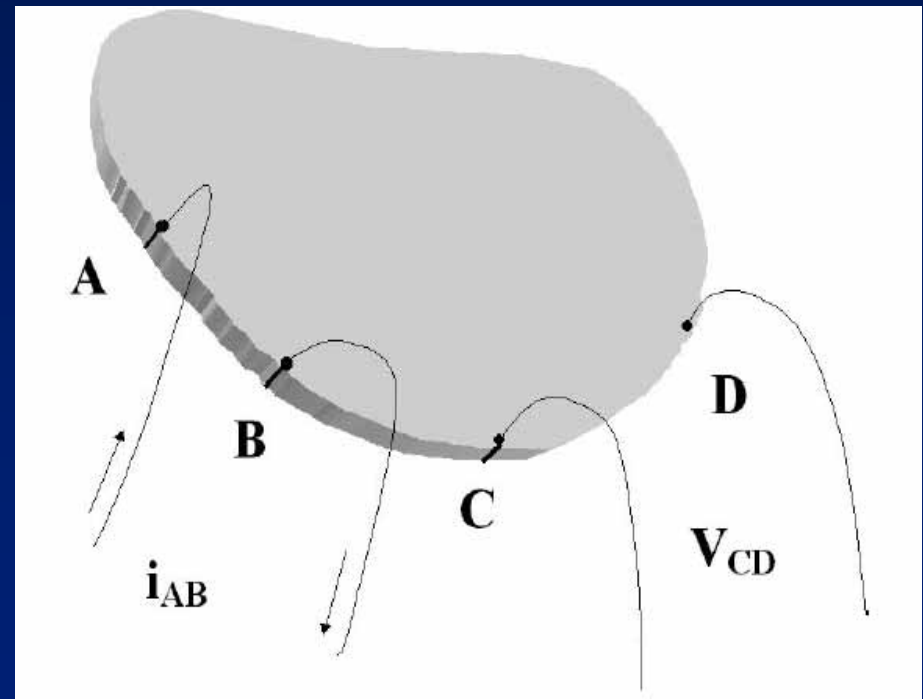
References

- [1]   E. S. D. Association, "ANSI/ESD S4.1-2006 For the Protection of Electrostatic Discharge Susceptible Items, Worksurface-Resistance Measurements," 1, ESD Association, 2006, p. 12.

- [2]   M. P. Gutiérrez, H. Li, and J. Patton, Thin Film Surface Resistivity, 2002.

- [3]   E. S. D. Association, "ANSI/ESD S20.20-1999, for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)," ESD Association, 1999, p. 18.

Thank You