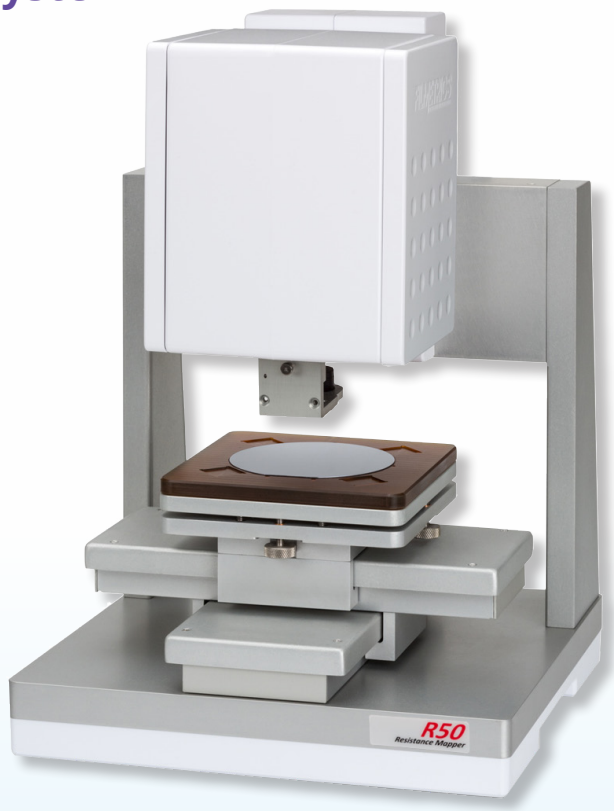
Filmetrics® R50 Series

Advanced Sheet Resistivity Mapping System

The Filmetrics R50 is the latest innovation in KLA sheet resistance and conductivity mapping systems. The R50 design represents a culmination of over 45 years of sheet resistance technology leadership. Since the introduction of our first resistivity gauge in 1975, the KLA family of companies has revolutionized the measurement of both sheet resistance and thickness for conductive layers.

Sheet resistance monitoring is critical to any industry that utilizes conductive films, from semiconductor manufacturing to the flexible electronics required to enable wearable technology. The R50 capabilities are optimized for metal film uniformity mapping, ion doping and implant characterization, film thickness and resistivity mapping, and non-contact film thickness measurement.



Advantages

- Available in Four-Point Probe (4PP) and non-contact Eddy Current (EC) configurations
- 100mm sample Z range with coarse and precision height control and approach
- Sheet resistance measurement spans a ten-decade range on conductive and semi-conductive films
- User-specified sample point mapping using rectangular, linear, polar, and custom configurations
- High precision X-Y stage provides travel up to 200mm
- Easy-to-use software interface
- Compatible with all KLA sheet resistance probes

Applications

- Semiconductors
- Compound semiconductors
- Advanced packaging
- Solar
- Flat panel and VR display
- Printed circuits
- Wearable devices
- Conductive materials

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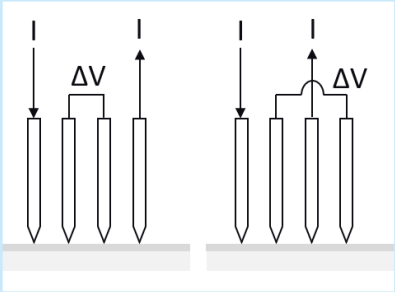
R50 Four-Point Probe and Eddy Current Methodology

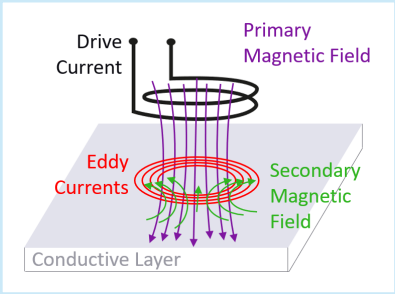
Four-Point Probe (4PP) and Eddy Current (EC) are two common techniques used to measure sheet resistance. The R50 delivers a technology-leading 10-decade range for the contact 4PP method and offers high resolution and high sensitivity configurations for the non-contact EC method, continuing KLA's history of innovation and leadership.

Four-Point Probe Overview



4PP provides a simple and direct measurement of resistance, where a probe consisting of four conductive pins contacts a conductive surface with a controlled force, with a non-conductive blocking layer between the measured conductive layer and the substrate. The standard pin configuration applies a current across the two outside pins and measures the voltage across the two inside pins.
For measuring sheet resistance, the conductive layer thickness should be less than ½ the pin spacing of the probe. KLA pioneered the R50 dual configuration technique that measures the voltage on alternate pins, applying dynamic correction for edge effects and adjusting for pin spacing error. KLA offers a wide range of probe pin configurations for any conductive film or ion implant layer to optimize for surface material properties.

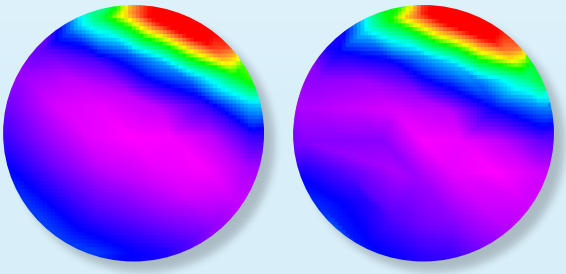
Eddy Current Overview



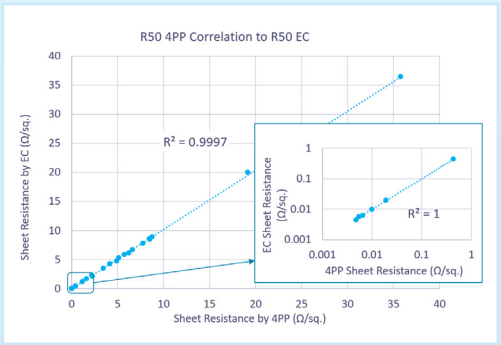
EC provides a non-contact technique for measuring conductive films. A time-varying current is applied through a coil to produce a time-varying magnetic field that, when brought close to a conductive surface, induces time-varying (eddy) currents in that surface. These eddy currents in turn create their own time-varying magnetic field that couples with the probe coil to create a signal change that is proportional to the sheet resistance of the sample. KLA's unique EC solution uses a single top side probe that dynamically adjusts for the probe sample height at each measured point, which is critical to measurement accuracy and repeatability. The EC method is unaffected by probe size or surface oxidation and is ideal for softer samples that are not well suited to the 4PP contact method.

Correlation Between 4PP and EC Methods

Whatever the application, KLA 4PP and EC solutions demonstrate over 99% correlation across the entire common range of each method. The Filmetrics R50 methods use KLA industry-leading calibration to ensure measurement accuracy regardless of technique.



Al on Si 4PP **Al on Si EC**



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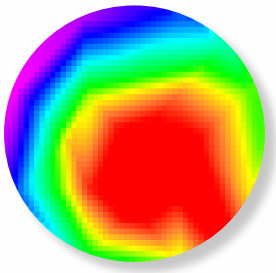
R50 Applications

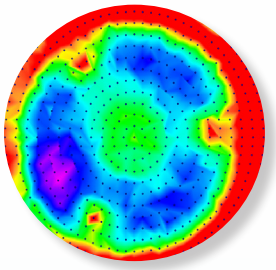
Metal Film Uniformity

Sheet resistance uniformity of metal films is critical to ensure device performance, and most metal films can be measured by both 4PP and EC. EC is recommended for thicker, highly conductive metal films and 4PP for thinner metal films (> 10Ω/sq), but very high 4PP/EC correlation ensures accurate results using either method. The R50 resistivity maps highlight film uniformity, deposition quality, and other process variations. This EC map of a 2µm AlCu film identifies and quantifies an off-center deposition.



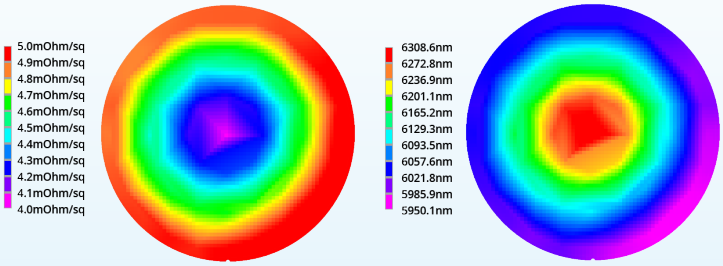
Ion Implantation Characterization

The 4PP probe is the standard technique for measuring ion implant processes. Mapping an ion implant after thermal annealing can identify hot and cold spots due to lamp failure, poor wafer/platen contact, or implant dose variations. For an ion implanted silicon layer, thermal annealing is required to activate the dopant ions. In the example at left, the three red (high resistance) spots indicate locations of greatest heat loss during ion (example right) implant anneal due to the three wafer supports. Temperature uniformity is critical for the annealing process, and heat loss at the wafer edge and contact points can be a serious challenge to activation uniformity.



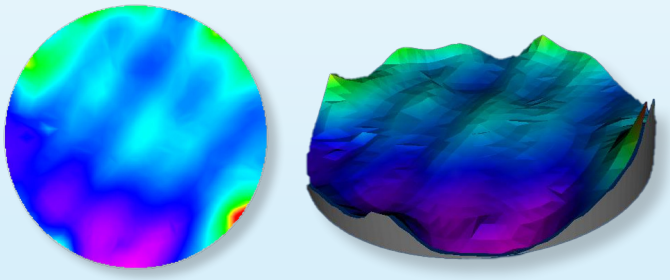
Film Thickness/Resistivity/Sheet Resistance

Measured wafer data can be mapped as sheet resistance, film thickness, or resistivity. By entering a resistivity value for a material, the thickness can be calculated and displayed; the resistivity can be calculated if the thickness value is entered.



Data Acquisition and Visualization

RSMapper is the R50 intuitive user interface that combines data acquisition and analysis features into a single platform that can be used on the tool itself or for offline analysis. Data acquisition for measurement sites can be easily specified using a variety of coordinate layouts. The RSMapper platform can display the measurement results in either 2D or 3D for quick visualization of critical film uniformity data, as shown for the ion beam scanning issue shown above. The software easily switches between maps of individual measurement parameters and rotatable 3D profiles to deliver customized views of the process parameters. Whether measuring sheet resistance, resistivity or metal film thickness, RSMapper delivers compelling visual data.



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R50 Specifications

General	R50-4PP/EC
Z Range	100mm
Z Stage Type	Automated
X-Y Stage Type	Automated
Sample Stage Max Weight	2.5kg
Tip-Tilt Stage	± 5°, Manual

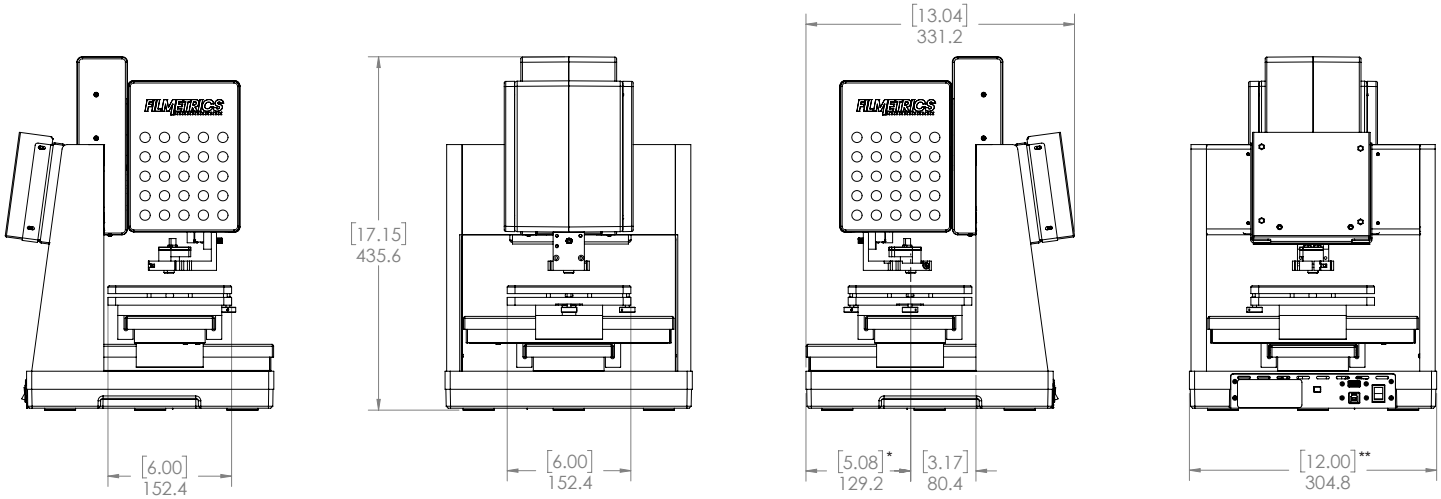
Electrical Performance	R50-4PP	R50-EC
Site Repeatability	< 0.2%	< 0.2%
Accuracy	± 1%	± 1%
Measurement Range[1]	1mΩ/sq – 200MΩ/sq	1mΩ/sq – 10Ω/sq
Matching[1]	< 1%	< 1%

[1]Typical value

Mechanical Performance	R50-4PP/EC	R50-200-4PP/EC
X-Y Stage Range	100mm x 100mm	200mm x 200mm
Sample Max Width	265mm	365mm
System Size (W x D x H)	305mm x 305mm x 550mm	406mm x 406mm x 550mm
System Weight	15kg	22kg

4PP P/N	Nominal Spring Load (g)	Nominal Spacing (mm)	Tip Radius (mm)	Needles Retraction (mm)	Type	Application
610-0590	100	1.016	0.04	0.25	A	Metals
610-0595	100	0.635	0.04	0.25	F	
610-0591	100	1.016	0.1	0.25	B	General purpose for implantation, doped poly, silicide and epitaxy
610-0596	100	0.635	0.1	0.25	G	
610-0592	100	1.016	0.2	0.25	C	Specifically designed for high impedance surfaces such as low implant dose
610-0597	100	0.635	0.2	0.25	H	
610-0593	100	1.016	0.5	0.25	D	Very difficult implant and high impedance surface beyond types C and H
610-0598	100	0.635	0.5	0.25	I	
610-0594	200	1.575	0.04	0.50	E	Substrate measurements

EC P/N	Frequency (MHz)	Nominal Coil Diameter (mm)	Type	Application
610-0599	10	1.5	EC A	Typical metal films up to 1Ω
610-0605	5	1.5	EC B	Higher resistance and thin metal films up to 50Ω



*179.2mm/7.05" for R50-200-4PP and R50-200-EC
**404.8mm/15.94" for R50-200-4PP and R50-200-EC

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