Model 680

Dynamic Four-Point Probe System

For Compound Semiconductor

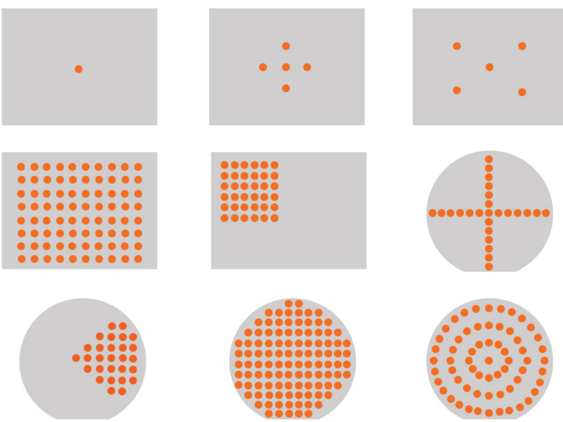
Four Dimensions Inc.
advanced metrology system

680 of dynamic four-point probe

Unlike using regular four-point probe, you can automatically measure and map sheet resistivities of epitaxial and ion implanted layers on GaAs, GaN, GaP, GaAlP, GaAsP, SiC, and other high contact resistance compound semiconductor with pinpoint accuracy, using Four Dimensions' new technique: the Dynamic Four Point Probe. First introduced and patented by Four Dimensions in the manual mode (System 880), it makes measurements using a special four-point-probehead together with precise combinations of AC and DC electrical test signals.

Now, the new production-oriented Automap System 680 gives you the freedom to make these samples' measurements conveniently and reliably then map them as a fully developed automatic mapping and data management system. You can use it to monitor for process control of compound semicondutor layers. These layers include MBE, ion-implanted, and MOCVD epitaxy.

Fully Automatic Measurements



The Automap System 680 is a fully developed production oriented system. It has Four Dimensions' complete Automap Software Package, which provides automatic one-point, five-point, and nine-point measurement arrays, diameter scans, and ASTM/SEMI X-patterns. It also permits full or partial wafer mapping employing up to more than 2000 measurement points per wafer in either Cartesian or Polar arrays, on 2-8" wafer. The system 680 precisely positions the probe at each site, finds the correct current range and gain, detects and rejects defective measurements and then display the good measured resistivity value.

Contact Precision

Four-point-probe technique provides superior resolution, good accuracy, long-term stability, and wide measurement range, compared with non-contact eddy current measurement, which combines sheet resistivities of the substrate with the layer on surface in measurement and results in uncertainty.

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New Measurement Technology

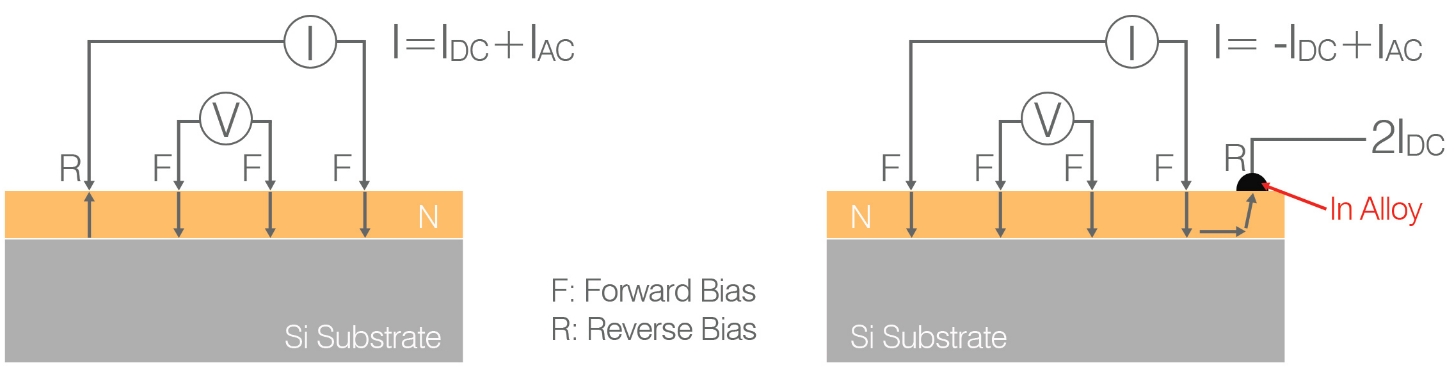
Dynamic four-point-probe technology specializes that the primary measurements are made with a dynamic AC electrical waveform rather than with conventional DC. Although it is well known that static four-point-probe is the standard method for measuring sheet resistivity of silicon layer or metal film, it is not suitable to be used, generally, to measure compound semiconductor layer due to much higher contact resistance of the needles to the layer.

This can be seen from reference [1] which compares the curves of characteristic current density J vs. forward voltage V_F for tungsten-Si and tungsten-GaAs contacts. In the figure, it shows that the forward current density J_F for the case of GaAs is almost 2 decades lower than that for Si, for the same forward voltage V_F. This means that needle-GaAs has a much higher contact resistance and noise than needle-Si. From these curves, however, a way can be seen to overcome high contact resistance problems of needle to GaAs. If a DC forward bias V_B is imposed on the probes, higher current densities J_F may be achieved. This can result in lower needle to GaAs contact resistances comparable to that of needle to Si. But using DC forward biasing makes it difficult for using DC to make good measurement. Therefore, by superimposing a low-frequency AC on the DC as the current for four-point probe measurement and employing a high-impedance phase locked loop (PLL) for the voltage amplifier, we can make the sheet resistivity measurement using just AC component with greatly reduced noise. System 680 also incorporates the sophisticated dual-configuration method for edge effect correction and elimination of probe wander errors.

[1] C.R.Crowell, J.C Sarace, and S. M. Sze, "Tungsten-Semiconductor Schottky Barrier Diodes," Trans. Met. Soc. AIME, 233, 478 (1965)

Dynamic Five-point Measurements

If the implanted layer is N-type, and the sheet resistivity is greater than 1000 Ω/sq, surface depletion may cause pinch-off below the reverse biased current probe. Should this occurs, it might not be possible to supply enough test current to generate the necessary measurement voltage. In that case, another technique is then used by the System 680. An additional fixed-position fifth contact is made at the edge of the water to supply reverse biased DC current for overcoming the pinch-off effect. This allows the same four-point probe to perform the measurement.



4 points measurement

5 points measurement

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Software

The Automap 680 has all the sophisticated analysis features you would expect in a complete wafer fabrication process control and data management system. Its Automap software package provides compound semiconductor device manufacturer (LED, or semiconductor laser for example)the ability to track production data. You may plot trend chart, check whether a process being within the control limits, using X-bar/R charts and histograms, retrieve contour and 3D maps, and display normalized group charts. Measurement data can be in sheet-resistivity (Ω/sq), bulk resistivity(Ω-cm), or layer thickness in μm or Å.

Analysis

- Color Contour Map
- 3D Surface Map
- Diameter Scan
- Partial Wafer Numerical Data Printout
- Differencing of Two Files
- Bulk Resistivity Measurement
- Feature Trend Chart, by Wafer/Day/Month
- Data Transfer to Spread Sheet / ASCII File
- Thickness, Temperature and Edge Correction
- Data Comparison
- Statistical Process Control (SPC)
  - X-bar/R Charts
  - Normalized Charts
  - Histograms
  - Periodic Cycle Checks

Computer

- Computer Type: Advanced PC Based System
- Monitor Type: 19" LCD
- Printer Type: HP color DeskJet
- Data Storage: 250GB HarDisk, 1GB RAM
- Process Memory Capacity: 200 Test Recipes
- Process Group Memory Capacity: 20 Groups
- Data Transfer: RS-232, SECS/GEM, and LAN

Measurement Specifications

The 680 system measurement capability is defined by the following specifications:

- Wafer Sizes: 50, 75, 100, 125, 150, 200mm diameter
- Test Diameter: any site, up to 3mm from wafer edge
- Quick-Checks: 1,5,9 matrix sites, 5,9,13 site X-patterns
- Catersian Maps: any site interval to the nearest mm up to 650 sites
- Diameter Scans: any site to the nearest mm
- Measurement Range: 10 mΩ/sq to 40 kΩ/sq
- Measurement Time: 10 seconds/site (dual configuration)
- Measurement Units: Ω/sq, Ω-cm, V/I, t(Å)
  Measurement Repeatability: $<$1%, typical (depending on layer, process, range)
- Accuracy of the electronics: 0.1% typical
- Repeatability of the electronics: $<$0.05% typical
- Two configurations switching for improved measurement
- performance and automatic edge correction
- Current and voltage set automatically for measurement.
- Measurement calibration NIST/VLSI traceable

Probes

- Probe Spacing: 1mm(standard), 0.5mm(optional)
- Probe Force Range: 60-200g(standard)
- Probe Head Type:
  - Type C:
    - Tip Radius: 100μm
    - Probe Material: Os Alloy

Facilities Requirements

- Power: 100/115/230 VAC, 50/60 Hz, 0.5 KVA
- Vacuum: 20" Hg at 1 liter/min air flow capability
- Tabletop Footprint: 30"depth x 55"width x 22"height

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Call today. For more information, call 1-510-782-1843 or visit us at www.4dimensions.com