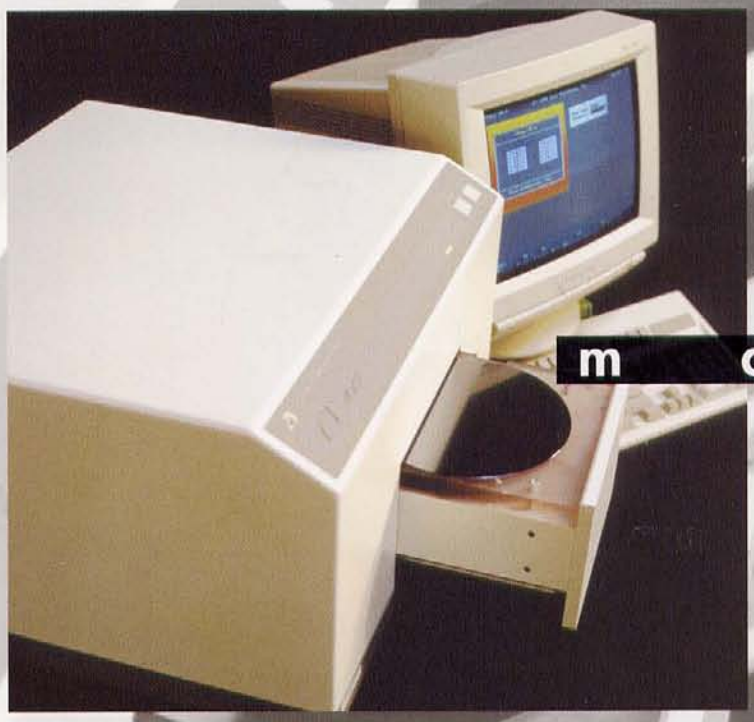
C V



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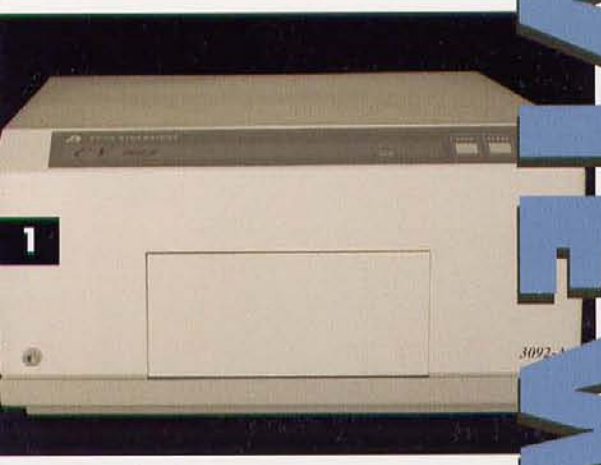
92/3092 series

OVERVIEW

MULTIPLE FUNCTION CAPABILITY



The CVmap92/3092 Series can perform C-V plots at various frequencies up to UHF and/or I-V plots in wide current range, at user specified sites. All of these can be done without going through metal deposition, photoresist work and etching steps in sample preparation. By using one to three mercury contacts (available in a wide range of areas) and a unique mechanism, these systems provide physical parameter mapping capabilities for many kinds of samples including SOI, low and high K films, extremely thin and thick oxide, compound semiconductors, carbon films, etc., with unsurpassed repeatability. Each system software can sort out stored data sets with the librarian method, analyzes and/or converts the data into various units, then displays them in programmable scales. Wafer maps of such characteristics as insulating film thickness, dielectric constant, leakage current, low dose ion implant dosage, epitaxial doping densities and carrier lifetime may be produced. Also, oxide integrity parameters such as Qbd, TDDB, defect density, breakdown voltage and interface trap distribution can be determined and plotted. Through connections to an external probe station, wafer with patterns of Si, Al or other kinds of gate can also be tested and mapped.

Application chart of CVmap92B/3092B is shown at between pages 2 and 3. Application chart of CVmap92A/3092A is the same except there is no pseudo MOST test in it.

FOUR DIMENSIONS

3140 Diablo Ave • Hayward, CA 94545 • Tel (510) 782-1843 • Fax (510) 786-9321 • e-mail: info@4dimensions.com

Various Advanced Setups for Better Measurements Of Difficult Samples

One can either take advantage of letting impedance meters such as Agilent 4285A, E4991A or Keithley 590 to work with the system or use the system's internal precision generator-integrator set for capacitance measurements. This means the user can choose the most appropriate setup to get the most correct C-V curve, or compare test results of different setups for investigation.
A bias in the form of step up/down, pulsed, or ramp up/down can be applied to the sample-under-test with or without attaching an external impedance meter to obtain C-V, I-V, Q-V, or C-t, I-t, Q-t data for extraction of parameters such as doping density, trap distribution, TDDB, and carrier generation lifetime. A selectable constant current can be applied to the sample-under-test for Qbd measurement. Measurement timing can be specified and adjusted for avoiding transients.
The mercury contact area can be very large for determining oxide defect density, very small for measuring intrinsic breakdown voltage, or in medium size for regular C-V measurements. The system can also be setup for more than 1000V breakdown test, much higher frequency than 1 MHz C-V measurements, and pseudo MOST test for SOI. Also, in most cases, using different measurement methods require no hardware change, which saves time and effort. Some measurements can be made one after another automatically through programming. All these are very helpful for investigation into different samples.

Excellent Mercury Contact Repeatablity, Cleanliness, and Safety

Due to our special method of making the mercury probe and the arrangement for refreshing the mercury before making each contact, mercury contact areas are very repeatable and mercury does not adhere to the wafer. The use of mercury reservoir which is covered by a rubber layer with an automatic closing mouth prevents accidental spilling. Since the mercury probe is facing up, there is no chance for mercury to drip down from the probe; it also allows us to make the probe for very small and/or very large mercury contact areas.

Advanced Software

The CVmap92/3092 A/B software has been designed with simplicity and versatility in mind. Here are some of its major features:

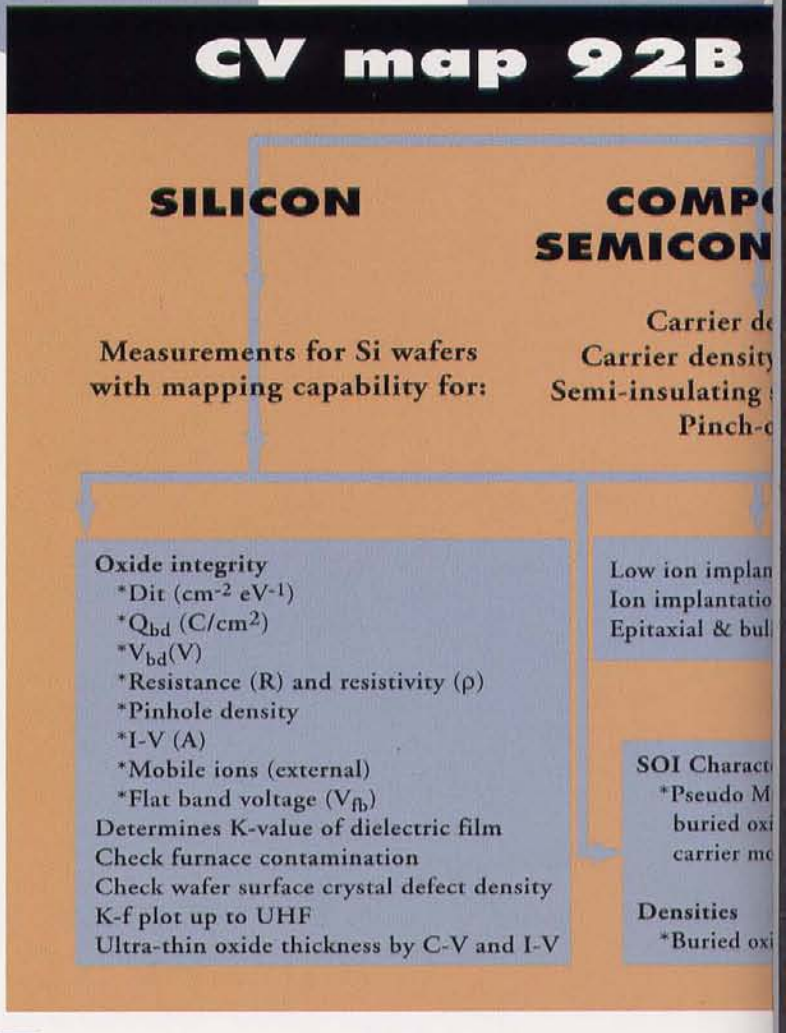
Multiple User Management

Access to operation functions such as measuring a wafer, configuring measurement methods, performing trouble shooting and recalling stored data may be selectively available to specific users. These access rights are fully configurable and are usually set by the engineer in charge.

Versatility of Configuring Measurement Methods

Measurement methods can be versatilely configured. Each measurement method is formed by a combination of parameters:

- Measurement parameters - These parameters define how the wafer will be measured. Specifics such as measurement frequency, pulse amplitude, bias voltage ramp and pulse timing are entered here.



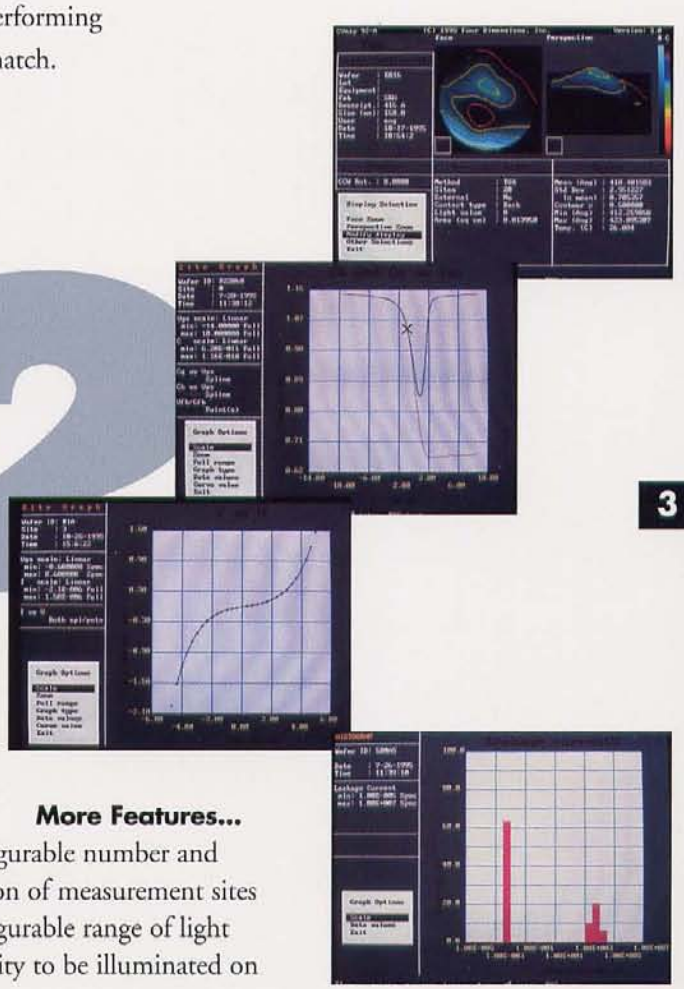
- Analysis parameters - These parameters determine how the data will be analyzed. Analysis constants, model and formulas are selected here.
- Display parameters - These parameters determine display formats, from combination of color for a map to the detail range and scale in an XY graph.
- Measurement sites - Through this setup, one can determine where the measurements will occur on the wafer. Arbitrary measurement positions may be specified in Cartesian and/or polar site coordinates

Stored Data Librarian

Access of a stored data set is a snap with our Stored Data Librarian. Just enter some search criteria such as wafer size, fab, equipment, operator, date of performing the measurement then the librarian will search all the stored wafers for a match. Only those matching your search criteria are displayed and you may then easily find the stored data set you want from there.

Comprehensive Display and Print-outs

Displays are provided in colorful high-resolution graphics. You will be impressed with contour and 3-D maps, which may be shown like a net or in contour with or without the reference background. There are many kinds of XY scales to let you specify for plotting the curve you want. Both the display and printout colors are user selectable.



Applications

…OUND
…DUCTOR

…nsity (cm^{-2})
… profiling (cm^{-3})
…ubstrate resistivity
…ff voltage

…ation dose (cm^{-2})
…n depth and profile
… doping density (cm^{-3})

…rization
…OST test for
…de-Si layer interface
…bilities and trap

…de leakage mapping

CARBON FILM MAPPING

I-V characteristic
Pinhole density

Ferroelectric characterization
- *K-E
- *P-E
- *K-f
- *K-T
- *Hysterisis loop plot

Carrier generation lifetime at the surface

More Features...

- Configurable number and position of measurement sites
- Configurable range of light intensity to be illuminated on wafer
- Characterizing ferroelectric film
- Measure defect density
- Monitor furnace contamination
- Configurable deep pulse sweeps
- Configurable quasi-static sweeps
- Configurable high frequency sweeps
- High voltage or VHF/UHF mercury probe
- Internal automatic calibration
- Back or ring return contact may be selected.
- External probing may be connected.
- Extremely small to large mercury dot available
- External meter attachment with Agilent 4285A, E4991A, or Keithley 590, 2410.

MEASUREMENTS METHOD

Quasi-Static CV:
Measured with one precision low amplitude long pulse on each step of the step-up or step-down bias function. The step duration is 2ms minimum. The measurement pulse amplitude is 50 mV, 100mV, or 150mV, with 1ms minimum duration.

High Frequency CV:
Measured with multiple internal low amplitude short pulses on each step of the step-up or step-down bias function, pulse amplitude being 50 mV, 100 mV, or 150 mV, duration 20ms or longer, or measured with the attached external impedance meter.

Quasi-static and High Frequency CV:
Combine the above two in one bias sweep.

Pulsed CV:
Measured with high frequency C-V measurement pulses by superimposing each of them on a bias pulse that is based on a DC bias at accumulation level. The bias pulse magnitude can be controlled to stay the same, to change with counts or to be in certain combinations; its range is ±100V, its duration 1ms or higher.

Generation Lifetime:
Using Current-Capacitance method

TDDB:
Using ramp voltage method, can test gate oxide on blank wafers.

Qbd:
Mercury gate, silicon gate or metal gate, all can be tested. Stress current can be selected from a multiple current source.

Defect Density:
Measure oxide leakage current at 20 or more sites on a wafer, and then statistically calculate the 95%-confidence-lever of upper limit and lower limit of defect density as well as the mean of defect density.

ANALYSIS AND MEASUREMENT CAPABILITIES

Furnace Contamination:
Monitoring contamination through defect distribution of the oxide grown in the furnace.

Ferroelectric Property:
Plotting hysterisis loop, response time, etc.

Doping Profiles:
Limited by breakdown or excessive leakage current, but the following range can be reached using high frequency or pulsed C-V plot:
Dope: 10^{13} to 10^{19} ions/cm^3. Depth: 0 to 30 microns. Repeatability: ±1.5% typical.

Flat Band Voltage:
Range: -10V to 10V
Repeatability: Depending on the trap density and the oxide thickness

Interface Trap Density:
Range: $2x10^{10}$ states/ev-cm^2 to $2x10^{12}$ states/ev-cm^2
Repeatability: ±5% or $±10^{10}$ states/cm^2 whichever is larger

Equivalent Oxide Thickness:
ange: 10Å to 20,000Å
Repeatability: ±0.3% typical

Ion Implant Dose:
Range: 10^{11} to $5x10^{12}$ ions/cm^2
Repeatability: ±0.3% typical

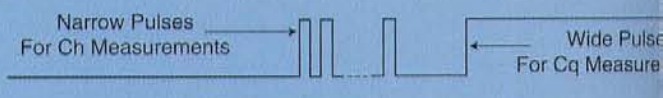
Epitaxial Doping Density:
Range: 10^{14} to 10^{18} cm^{-3}
Repeatability: ±2% typical

Epitaxial Thickness:
Range: 0.3 to 20 microns, depending on the doping density.
Repeatability: ±3% typical

Generation Lifetime:
Range: 0.01µs to 100ms.
Repeatability: ±10% typical

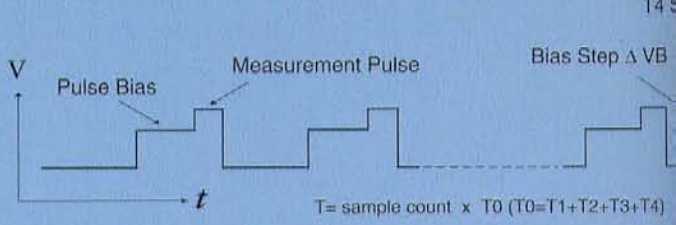
Quasi-static and High Frequency Wa

FIGURE 1



Deep Pulse Sweep Waveform

FIGURE 2



EQUIPMENT GENERAL

Insulating Film and Semi-Insulating Layer Resistivity:

Range: 10^6 to 10^{18} ohm-cm, in 10Å to 1mm thickness.

Graphic Capability

Contour maps and 3-D maps: oxide thickness, doping density, interface trap density and mobility, flat band voltage, ion implantation close, carrier lifetime, insulating film and semi-insulating layer resistivities.

X-Y Plot:
C-V, I-V,
N-W, W-V,
Dit-Et, TDDB,
Qbd, pseudo MOST characteristic, etc.

Histogram:

Leakage current distribution, resistivity distribution.

CVmap Station:

Capacitance Measurement Range: 0 to 20,000 through PF internal meter, or limited by the specification of the external meter.

Current Measurement Range: 50fA to 1mA

Bias Available: -100 to 100 Volts internal, or specified by the external meter.

Measurement Pulse: 50mV,100mV,or 150mV, >20µs for Ch, >1ms for Cq

Wafer Size Handlable: From 1cm x 1cm square chip to 12" round wafer.

Probe: mercury dot from $2x10^{-5}$ cm^2 to 0.8 cm^2 without mercury ring or with one to 2 mercury rings or external probe station.

Probe Return: mercury ring, wafer back or external.
Compressed Air:
60 PSI minimum

Vacuum: 28 inch Hg minimum

Power: 120 volts, 60Hz, 220/240 volts, 50/60 Hz, 100 volts, 50/60 Hz, 300 VA

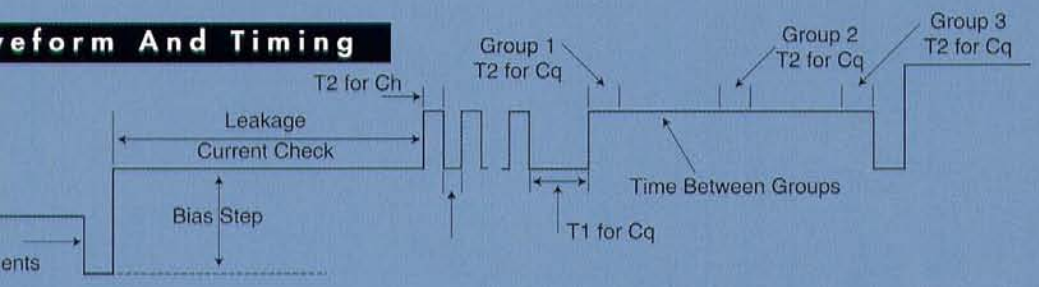
Standard Controller:

Pentium 233MHz, 16MB RAM minimum, 30GB hard disk minimum, 3.5", 1.44MB floppy disk minimum, compact disc capability.
101 Keyboard
Super VGA-640*480, 256 colors

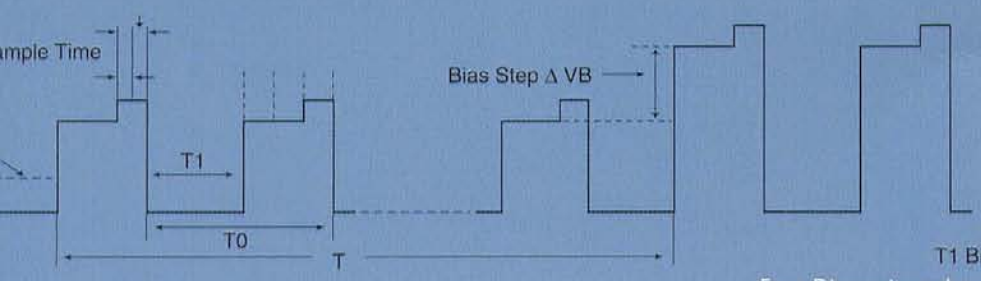
Printer:

HP Deskjet

eform And Timing



And Timing



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