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Lab Report III

Finding the resistivity using 4 probs

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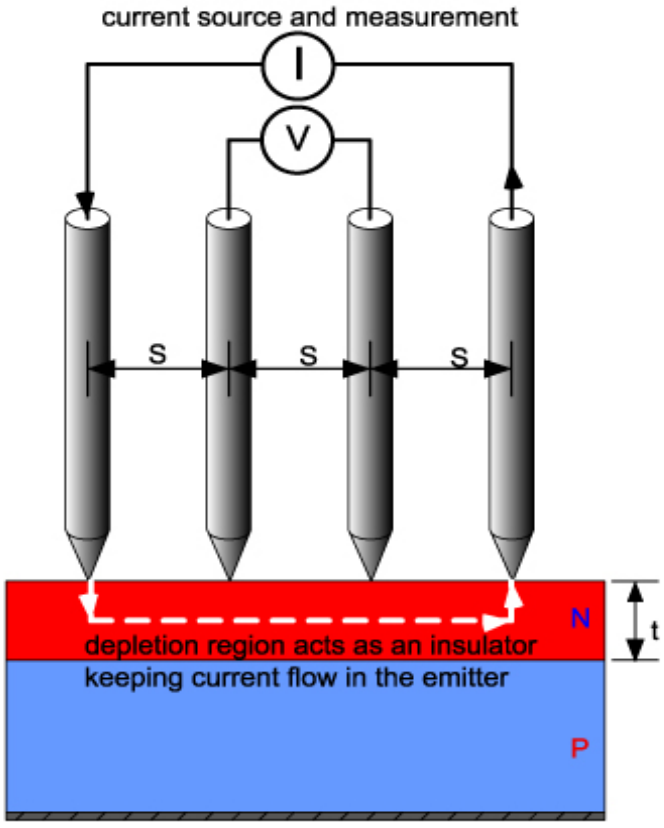
EE21M005

Objective: Use probe4 resistivity and measure the sheet resistivity (ohm-cm) of a **Si** sample. By knowing the sheet resistance we can calculate the resistivity with multiplying the thinness of the sheet

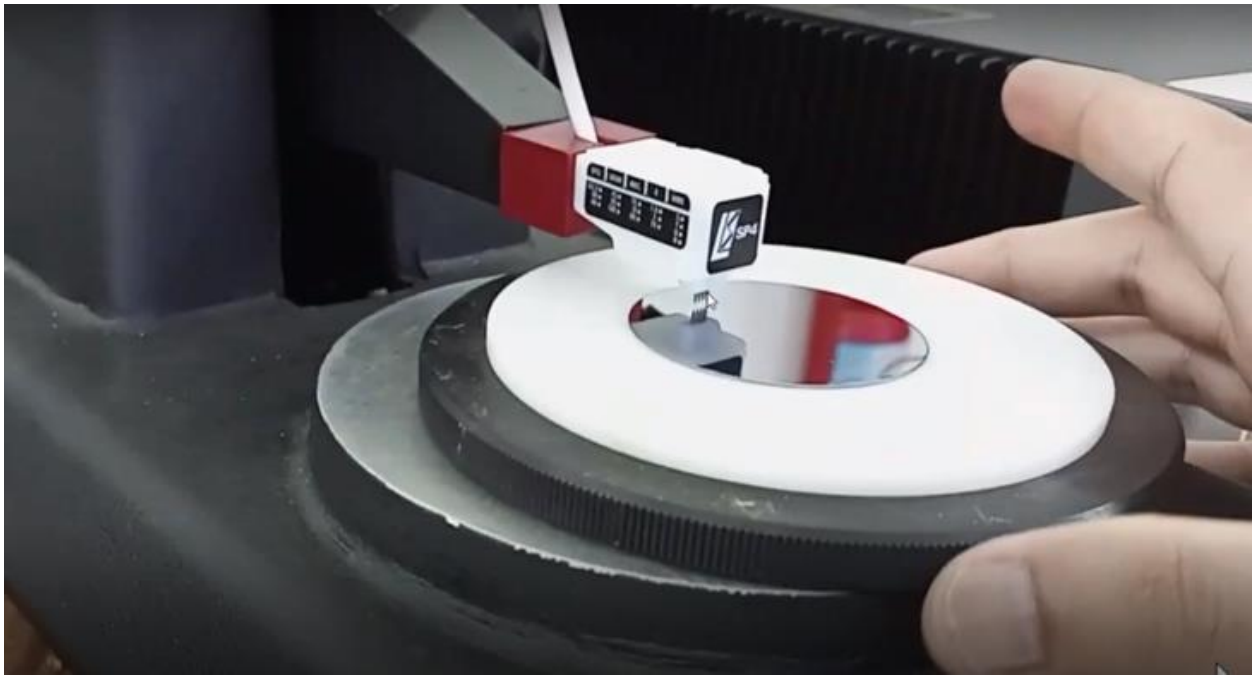
Theory :

The sheet resistivity of the top emitter layer is very easy to measure experimentally using a "four point probe". A current is passed through the outer probes and induces a voltage in the inner voltage probes. The junction between the *n* and *p* -type materials behaves as an insulating layer and the cell must be kept in the dark.



Procedure:

Let's take a p-type Si wafer which is having 2 inch diameter and thickness 500 micro meters.

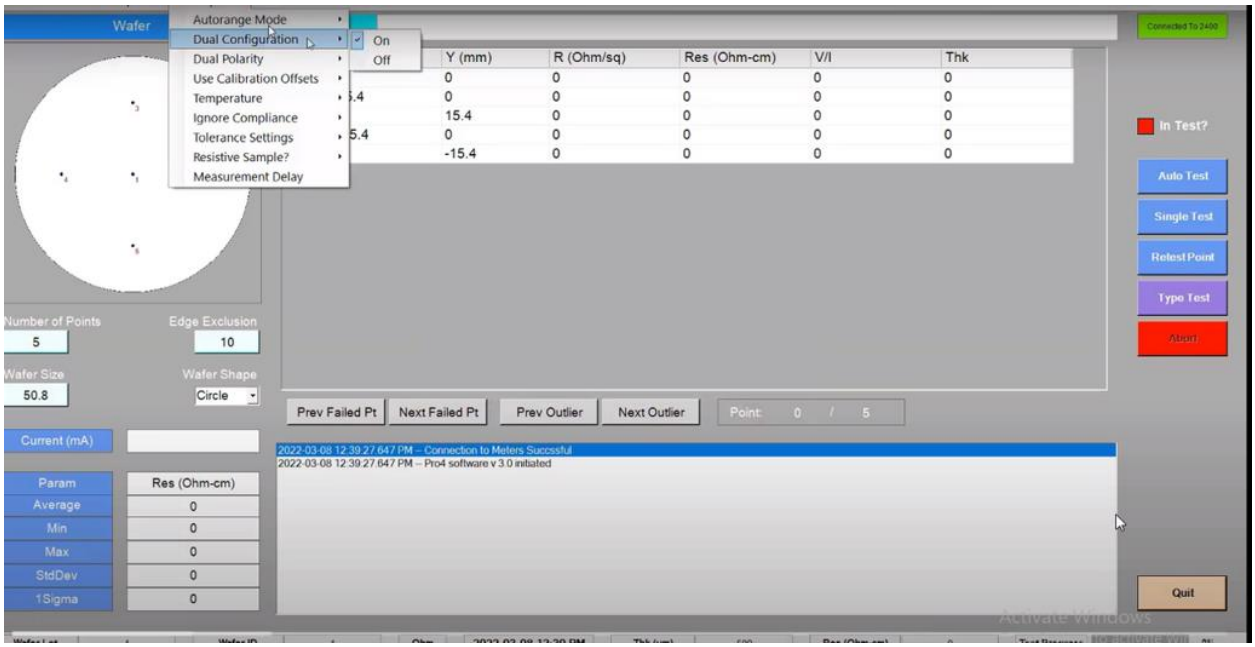


Signatone four probe resistivity meter has 4 probes and these probes are collinear , with the help of inner two probes we measure the current and remaining two use to measure voltage. Ratio of voltage and current gives the resistivity of the sample. Current in the inner probes flows in the order of mille or micro amps.

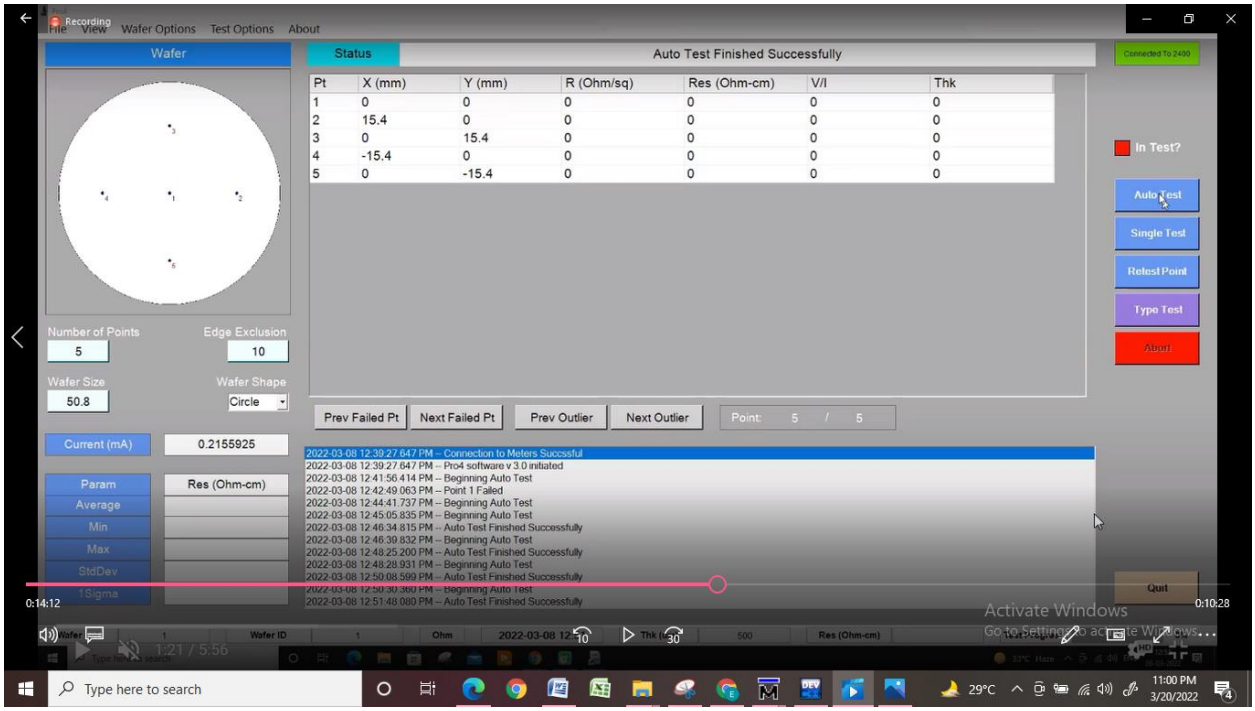
Following picture is 2410 Source meter which is used for probing current and voltage simultaneously. It can detect up to 1100 v.

➔ While takeing the measurements these 4 probes have to be tight contact with si wafer surface.

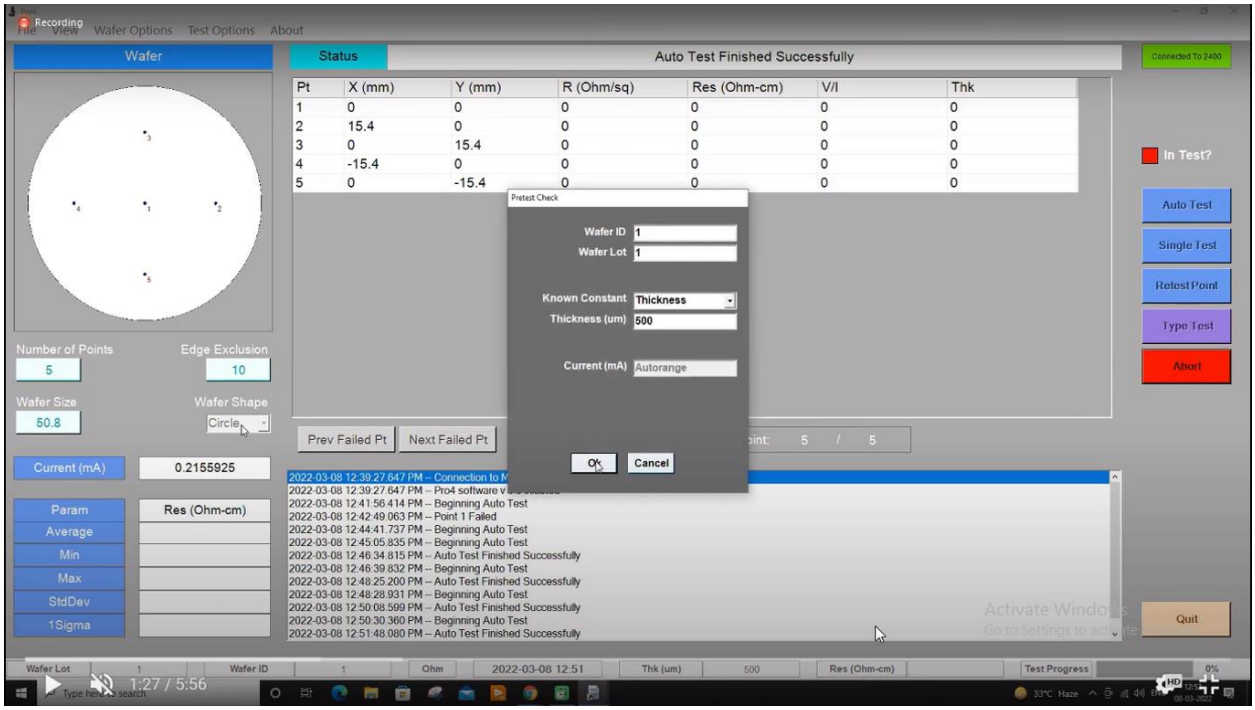
➔ Software used here is probe4
Various options available in prob4 interface.

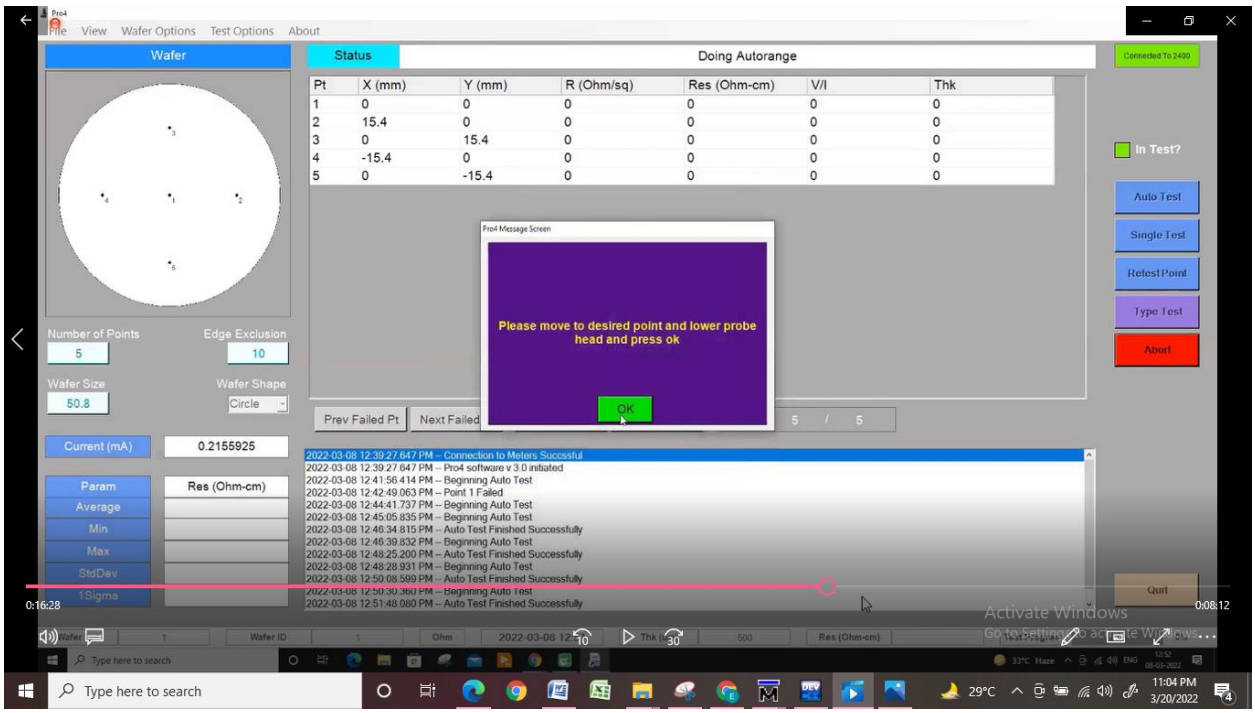


Auto range mode is selects range of currents from micro amps to mill amps, and measures voltages. We use NIST certified calibration, dual configuration is to choose the either positive or negative type of current. Complacence value is upper limit of the current or voltage to measure.



Single test:


Recording
File View Wafer Options Test Options About
Wafer
Status
Auto Test Finished Successfully
Connected To 2400
Pt X (mm) Y (mm) R (Ohm/sq) Res (Ohm-cm) V/I Thk
1 0 0 0 0 0 0
2 15.4 0 0 0 0 0
3 0 15.4 0 0 0 0
4 -15.4 0 0 0 0 0
5 0 -15.4 0 0 0 0
In Test?
Auto Test
Single Test
Retest Point
Type Test
Abort
Pretest Check
Wafer ID 1
Wafer Lot 1
Known Constant Thickness
Thickness (um) 500
Current (mA) Autorange
OK
Cancel
Number of Points 5
Edge Exclusion 10
Wafer Size 50.8
Wafer Shape Circle
Prev Failed Pt
Next Failed Pt
Current (mA) 0.2155925
Param Res (Ohm-cm)
Average
Min
Max
StdDev
1Sigma
2022-03-08 12:39:27.647 PM -- Connection to M
2022-03-08 12:39:27.647 PM -- Pro4 software v
2022-03-08 12:41:56.414 PM -- Beginning Auto Test
2022-03-08 12:42:49.063 PM -- Point 1 Failed
2022-03-08 12:44:41.737 PM -- Beginning Auto Test
2022-03-08 12:45:05.835 PM -- Beginning Auto Test
2022-03-08 12:46:34.815 PM -- Auto Test Finished Successfully
2022-03-08 12:46:39.832 PM -- Beginning Auto Test
2022-03-08 12:48:25.200 PM -- Auto Test Finished Successfully
2022-03-08 12:48:28.931 PM -- Beginning Auto Test
2022-03-08 12:50:08.599 PM -- Auto Test Finished Successfully
2022-03-08 12:50:30.360 PM -- Beginning Auto Test
2022-03-08 12:51:48.080 PM -- Auto Test Finished Successfully
Quit
Activate Windows
Wafer Lot 1 Wafer ID 1 Ohm 2022-03-08 12:51 Thk (um) 500 Res (Ohm-cm) Test Progress 0%
1:27 / 5:56


File View Wafer Options Test Options About
Wafer
Status
Doing Autorange
Connected To 2400
Pt X (mm) Y (mm) R (Ohm/sq) Res (Ohm-cm) V/I Thk
1 0 0 0 0 0 0
2 15.4 0 0 0 0 0
3 0 15.4 0 0 0 0
4 -15.4 0 0 0 0 0
5 0 -15.4 0 0 0 0
In Test?
Auto Test
Single Test
Retest Point
Type Test
Abort
Pro4 Message Screen
Please move to desired point and lower probe head and press ok
OK
Number of Points 5
Edge Exclusion 10
Wafer Size 50.8
Wafer Shape Circle
Prev Failed Pt
Next Failed
Current (mA) 0.2155925
Param Res (Ohm-cm)
Average
Min
Max
StdDev
1Sigma
2022-03-08 12:39:27.647 PM -- Connection to Meters Successful
2022-03-08 12:39:27.647 PM -- Pro4 software v 3.0 initiated
2022-03-08 12:41:56.414 PM -- Beginning Auto Test
2022-03-08 12:42:49.063 PM -- Point 1 Failed
2022-03-08 12:44:41.737 PM -- Beginning Auto Test
2022-03-08 12:45:05.835 PM -- Beginning Auto Test
2022-03-08 12:46:34.815 PM -- Auto Test Finished Successfully
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2022-03-08 12:48:28.931 PM -- Beginning Auto Test
2022-03-08 12:50:08.599 PM -- Auto Test Finished Successfully
2022-03-08 12:50:30.360 PM -- Beginning Auto Test
2022-03-08 12:51:48.080 PM -- Auto Test Finished Successfully
Quit
Activate Windows
0:16:28
0:08:12
Type here to search
29°C
11:04 PM
3/20/2022

Single Test results:

Pt	X (mm)	Y (mm)	R (Ohm/sq)	Res (Ohm-cm)	V/I	Thk
1	0	0	91262.070313	4556.056641	20141.705078	500
2	15.4	0	0	0	0	0
3	0	15.4	0	0	0	0
4	-15.4	0	0	0	0	0
5	0	-15.4	0	0	0	0

Auto test:

Here we are performing 5 point measurements. So, each time have to move the point when following message displace.

Test results for auto test:

Status | Auto Test Finished Successfully

Pt	X (mm)	Y (mm)	R (Ohm/sq)	Res (Ohm-cm)	V/I	Thk
1	0	0	93184.6875	4652.039063	20566.03125	500
2	15.4	0	93820.101563	4683.760254	20706.267578	500
3	0	15.4	93962.726563	4690.880859	20737.746094	500
4	-15.4	0	94520.890625	4718.745605	20860.933594	500
5	0	-15.4	95096.820313	4747.498047	20988.041016	500

Type test:

Here we need to make sure that 4 probes contact with si wafer.

Verify with analytical expressions