ATAMI Standard Operating Procedure

Jandel 4-pt Probe

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Revision	Date	Description/Change	Curator
0	12/13/19	New document	Randy Greb

Contents

Scope:

Resistivity measurements using the Jandel 4-pt probe with the RM3000 test unit and standard, 1mm spacing probe head.

System Specifications:

See Atami Website.

Safety

General

Standard lab practices.

PPE Required

Normal room PPE.

Hazardous Energies

Electrical

NA

Mechanical

NA

Stored/Potential

NA

Thermal

NA

Materials/Consumables Hazards

Use caution not to damage the probe heads. Physical damage or contamination on the surface of the probes can affect measurements.

Interlocks

NA.

Training Requirements

1. Pass all ATAMI required safety courses
2. Finish lab tour with qualified ATAMI trainer.
3. Complete all hands on training for this system and signed off by trainer.
4. Verify access to this document for reference.

Standby Condition:

RM3000 turned off.

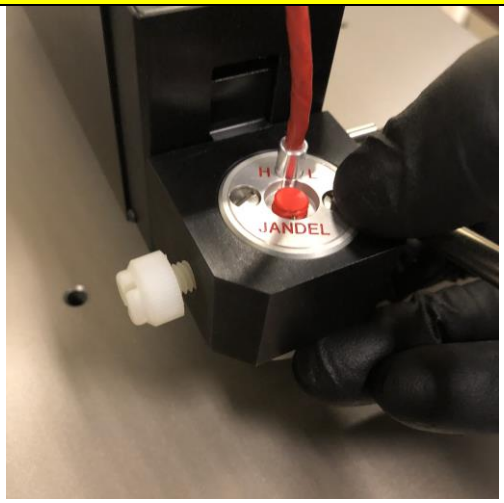
Probe in the up position with the cover back on.

Measurement distance set for a glass slide. **If you change probe height, please change it back to the standard glass slide height as the default for other users.**

Procedures

Take a basic resistivity measurement:

Step	Action	Notes
	If your sample is a 1mm thick glass slide with approximately the same thickness as the reference slide, proceed with the next steps. If not, complete the change measurement height procedure below, and then continue.	
1	Carefully unlock the probe head, slide it up, and remove the cover.	 →  **Do not touch the probe tips.**

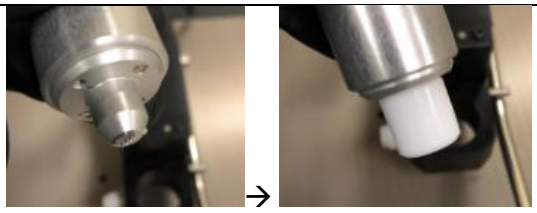
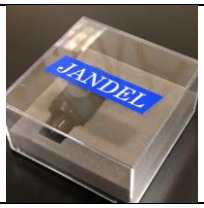
Step	Action	Notes
2	Move the probe head back in position. The top of the head should be level with the clamp.	
3	Log in to the card reader.	
4	Turn on the RM3000.	The power switch is on the left, back side.
5	Place your sample under the head and lower the lever arm until the micro-switch on the right side activates and the probe head is in contact with the sample.	If you are measuring a wafer, place the probe at the center of the wafer to minimize geometrical effects on sheet resistance. You can auto-range for correct current by pressing and holding the “STBY/AUTO” button. You can also use one of the pre-set currents: A - 10mA B - 1mA C - 100uA D - 100nA
6	The result will display in current and volt units.	

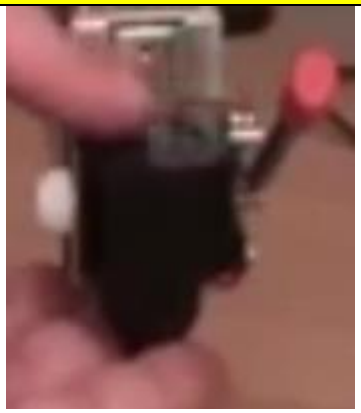
Step	Action	Notes
		You can press the ohm-square button to toggle between ohm-square and I/V displays. 
7	Press the "REV" button to measure in the reverse direction to verify the measurement.	The measured value should be very close to the forward value to indicate a valid measurement.
8	**Always return the unit to standby by pressing the STBY/Auto button, before raising the probe head and moving to another sample**	

How to shut down the system:

Step	Action	Notes
1	Be sure the system is in standby.	
2	Raise the probe head.	
3	Turn off the power to the RM3000.	
4	If you changed the probe height, please be sure to return it to the 1mm standard height using the procedure outlined below.	
5	Replace the cover on the probe tips.	
6	Log out of the card reader.	

How to set the probe height:

Step	Action	Notes
7	Loosen the clamp screw and raise the whole assembly.	
8	Remove the test probe and make sure it is covered.	
9	Place the dummy probe in the test head so that the top is level with the top of the mounting block and lighten tighten the set screw.	

Step	Action	Notes
		
10	Lower the probe head slide until the micros-switch is fully engaged.	
11	Lower the assembly so that the tip of the dummy probe is just touching the top of the sample.	
12	Tighten the clamp to set the level.	
13	Lift the probe head slide unit so that it is fully raised.	
14	Replace the dummy probe head with the probe head.	You will need to remove the cover if you are doing measurements.

Standard or Example Recipes

Very low resistivity material

e.g. aluminium, gold, platinum requires the maximum current from the current source to achieve a readng on the digital voltage display. Only very thin films from 100's of Angstroms up to 1 micron thickness can be measured. Samples with expected sheet resistance figures of less than 1 ohm per square need a better voltmeter.

High sheet resistivity material e.g. ion-implanted silicon wafers, silicon on sapphire, can be measured using very low currents (say 1 microamp or less) and trying to avoid a greater voltage indication than 200mV. Probably sheet resistance up to 107 ohms per square can be measured.

Basic Troubleshooting

If:

Step	If	Then	Notes
1	**You get a "Contact Limit" message.**	This indicates and insulating film or not contact of the probe tips. Check your film and or probe height setting.	
2	**You get a very low V reading, even with a very high current.**	This indicates a highly conductive sample, or even a short across the two inner tips. If you suspect an issue with the probe tips, contact Atami staff.	

Attachments

Excellent References on 4-point probe measurements and equations:

http://four-point-probes.com/notes-on-four-point-resistivity-measuring-with-jandel-equipment/

Notes on sheet resistance Calculations:

If the spacing between the probe points is constant, and the conducting film thickness is less than 40% of the spacing, and the edges of the film are more than 4 times the spacing distance from the measurement point, the average resistance of the film or the sheet resistance is given by:

Rs = 4.53 x V/I

The thickness of the film (in cm) and its resistivity (in ohm cm) are related to Rs by:

Rs = resistivity/thickness

Therefore one can calculate the resistivity if the thickness of a film is known, or one may calculate the thickness if the resistivity is known.

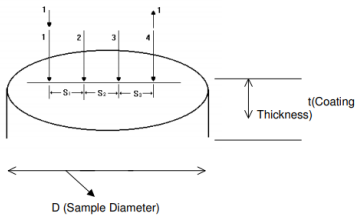
Correction Factors for Thin Rectangular Slices (NIST):

http://four-point-probes.com/haldor-topsoe-geometric-factors-in-four-point-resistivity-measurement/

Haldor Topsoe, Page 53, "Thin Rectangular Slice" 78K PDF
Haldor Topsoe, Page 54, "Thin Rectangular Slice" (continued) 83K PDF
Haldor Topsoe, Page 55, **Graph** – "Thin Rectangular Slice" 401K PDF
Haldor Topsoe, Page 56, "Thin Rectangular Slice" (continued) 94K PDF
Haldor Topsoe, Page 57, **Graph** – "Thin Rectangular Slice" (continued) 439K PDF
Haldor Topsoe, Page 58, "Narrow Rectangular Slice" (continued) 113K PDF
Haldor Topsoe, Page 59, **Graph** – "Thin and Narrow Rectangular Slice" (continued) 498K PDF
Haldor Topsoe, Page 60, "General Considerations of Finite Slices" 128K PDF
Haldor Topsoe, Page 61, "General Considerations of Finite Slices" (continued) 148K PDF
Haldor Topsoe, Page 62, "General Considerations of Finite Slices" (continued) 139K PDF

Correction Factors:

Sheet Resistance (RS) = p/t= (V/I) X C.F.1 X C.F.2 X C.F.3



C.F.1

D / s	Circle	Square	Rectangle L/W=2	Rectangle L/W=3	Rectangle L/W=4
1				0.9988	0.9994
1.25				1.2467	1.2248
1.5			1.4788	1.4893	1.4893
1.75			1.7196	1.7238	1.7238
2			1.9475	1.9475	1.9475
2.5			2.3532	2.3541	2.3541
3	2.2662	2.4575	2.7000	2.7005	2.7005
4	2.9289	3.1127	3.2246	3.2248	3.2248
5	3.3625	3.5098	3.5749	3.5750	3.5750
7.5	3.9273	4.0095	4.0361	4.0362	4.0362
10	4.1716	4.2209	4.2357	4.2357	4.2357
15	4.3646	4.3882	4.3947	4.3947	4.3947
20	4.4364	4.4516	4.4553	4.4553	4.4553
32	4.4791	4.4878	4.4899	4.4899	4.4899
40	4.5076	4.5120	4.5129	4.5129	4.5129
Infinity	**4.5324**	**4.5324**	**4.5325**	**4.5325**	**4.5324**

C.F.2

t / s	C.F.2
< 0.4	**1.000**
0.400	0.9995
0.500	0.9974
0.555	0.9948
0.625	0.9896
0.714	0.9798
0.833	0.9600
1.000	0.9214
1.111	0.8907
1.250	0.8490
1.429	0.7938
1.667	0.7225
2.000	0.6336

C.F.3

Ohm.cm / Temp (℃)	0~20 ohm.cm	21~50 ohm.cm	51~120 ohm.cm	121~ Infinity ohm.cm
10	0.9010	0.9020	0.9012	0.9006
12	0.9140	0.9138	0.9138	0.9140
14	0.9290	0.9275	0.9275	0.9278
16	0.9440	0.9422	0.9425	0.9428
18	0.9596	0.9582	0.9580	0.9582
20	0.9758	0.9748	0.9750	0.9750
22	0.9920	0.9915	0.9920	0.9922
23	**1.0000**	**1.0000**	**1.0000**	**1.0000**
24	1.0080	1.0078	1.0080	1.0082
26	1.0248	1.0248	1.0251	1.0252
28	1.0410	1.0440	1.0428	1.0414
30	1.0606	1.0600	1.0610	1.0612