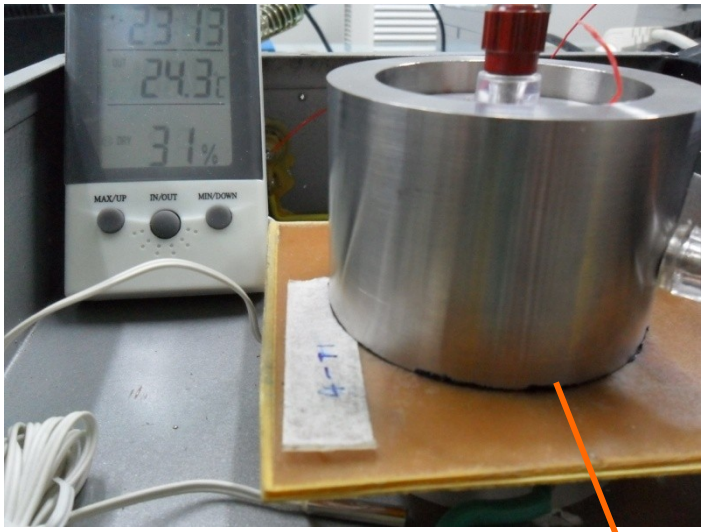
Updated Resistivity measurement on Mm-Batch-4 Bakelite & RPC Bakelite sample measurements

Updated Mm-Batch-4 Bakelite Measurements

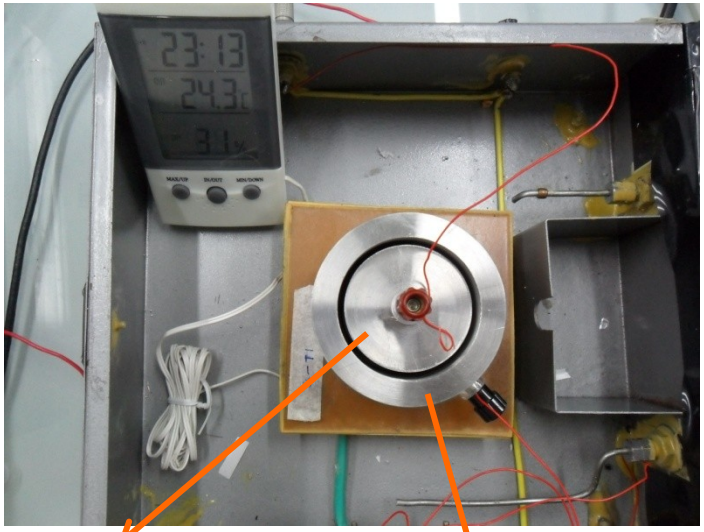
Test Electrode

Side view



Carbon-film

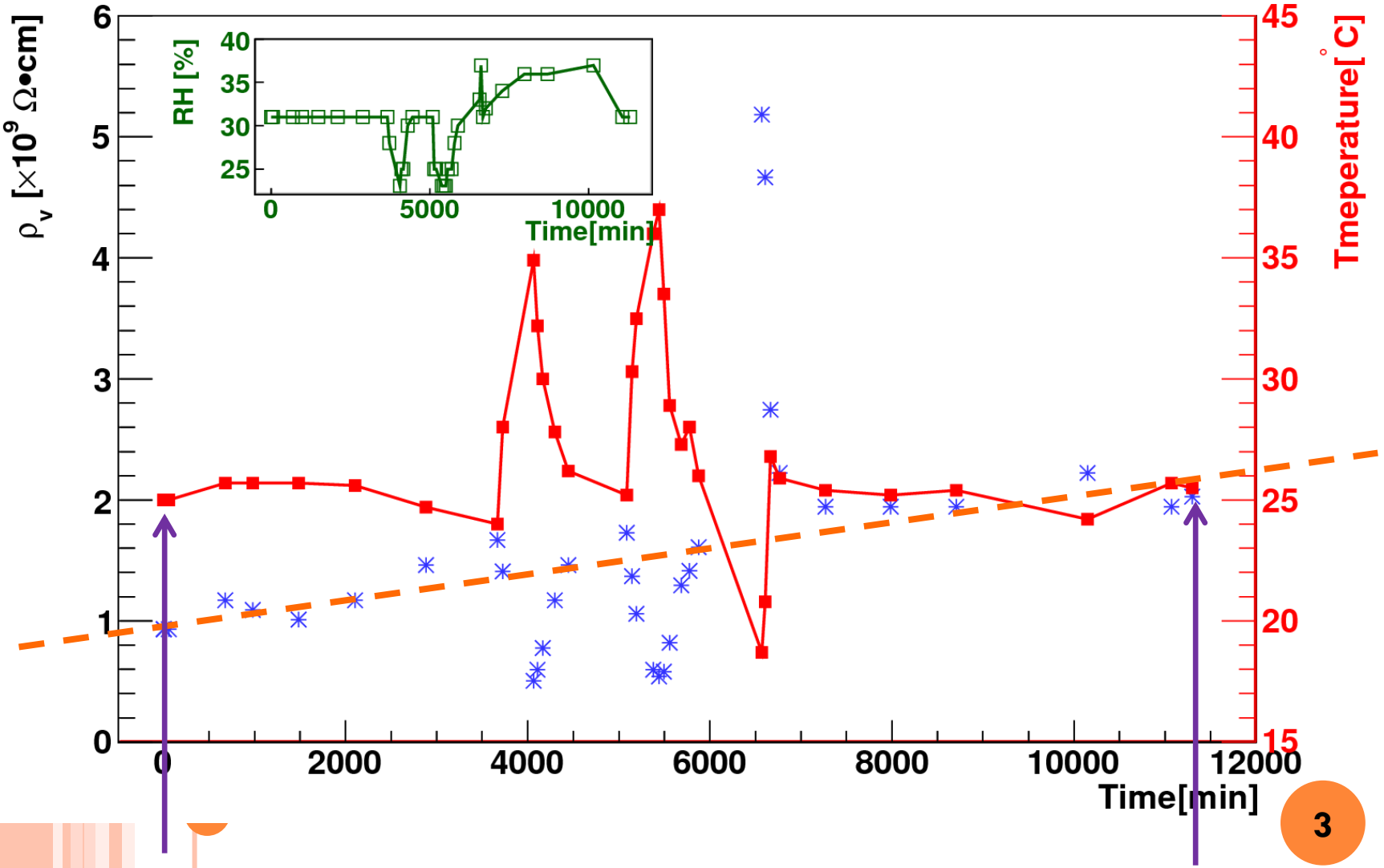
Top view



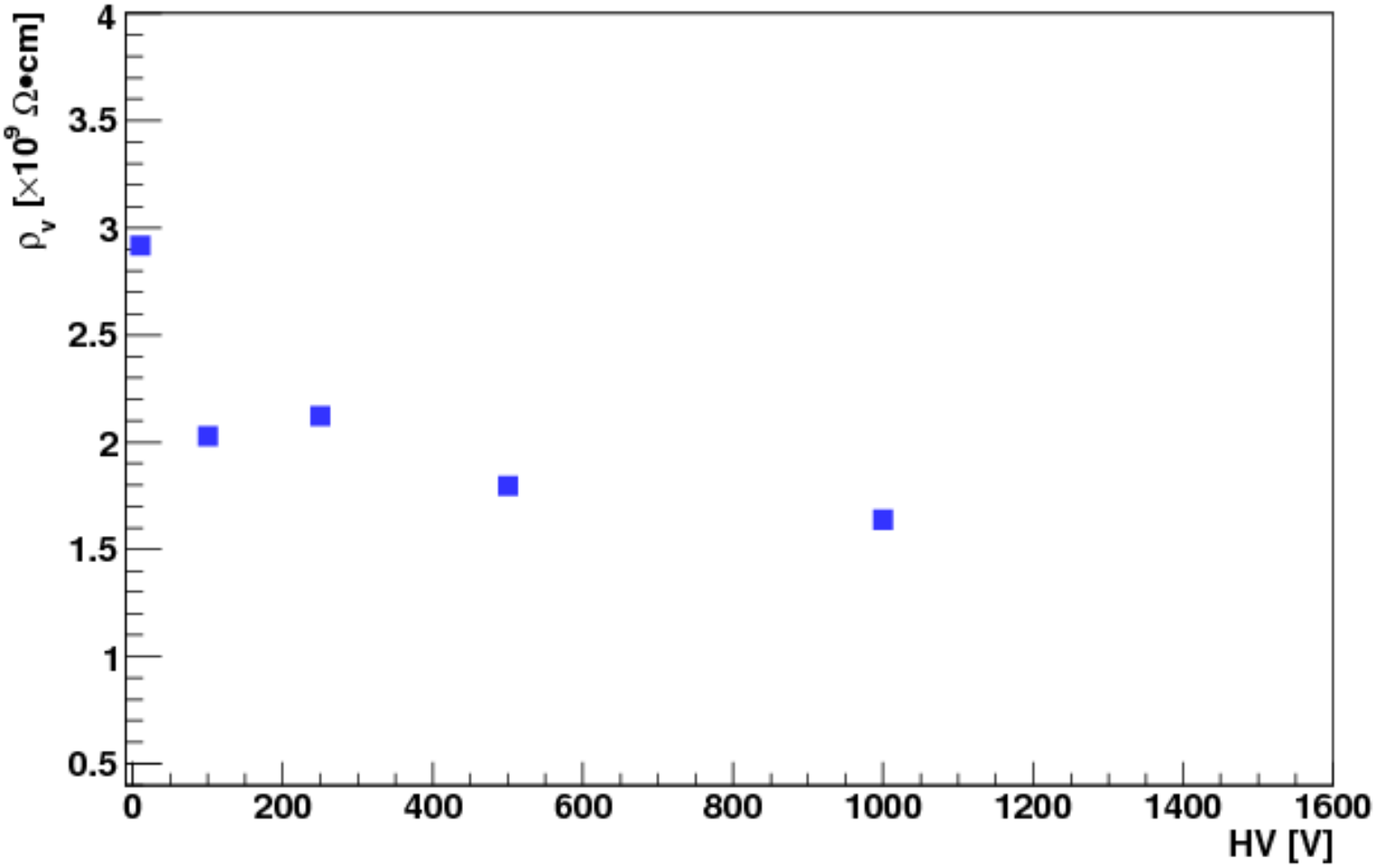
Guarded electrode

Guard electrode

Long term stability



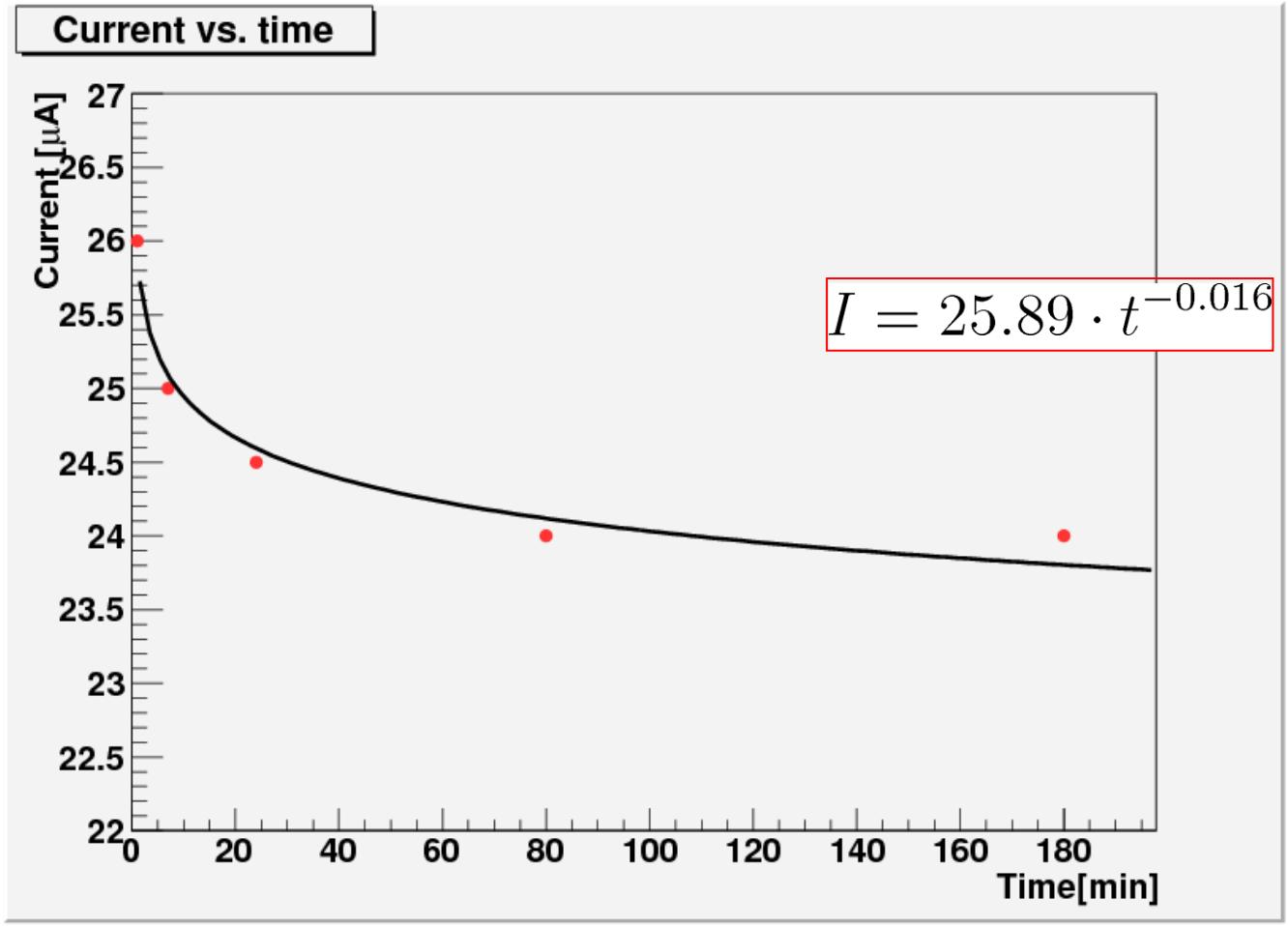
Bulk Resistivity vs. HV



** Current is read out within 2 min charging time.*

Charging Time

U=500V T: 25.9C RH:31%



TGRPC –Bakelite Sample Measurements

Samples

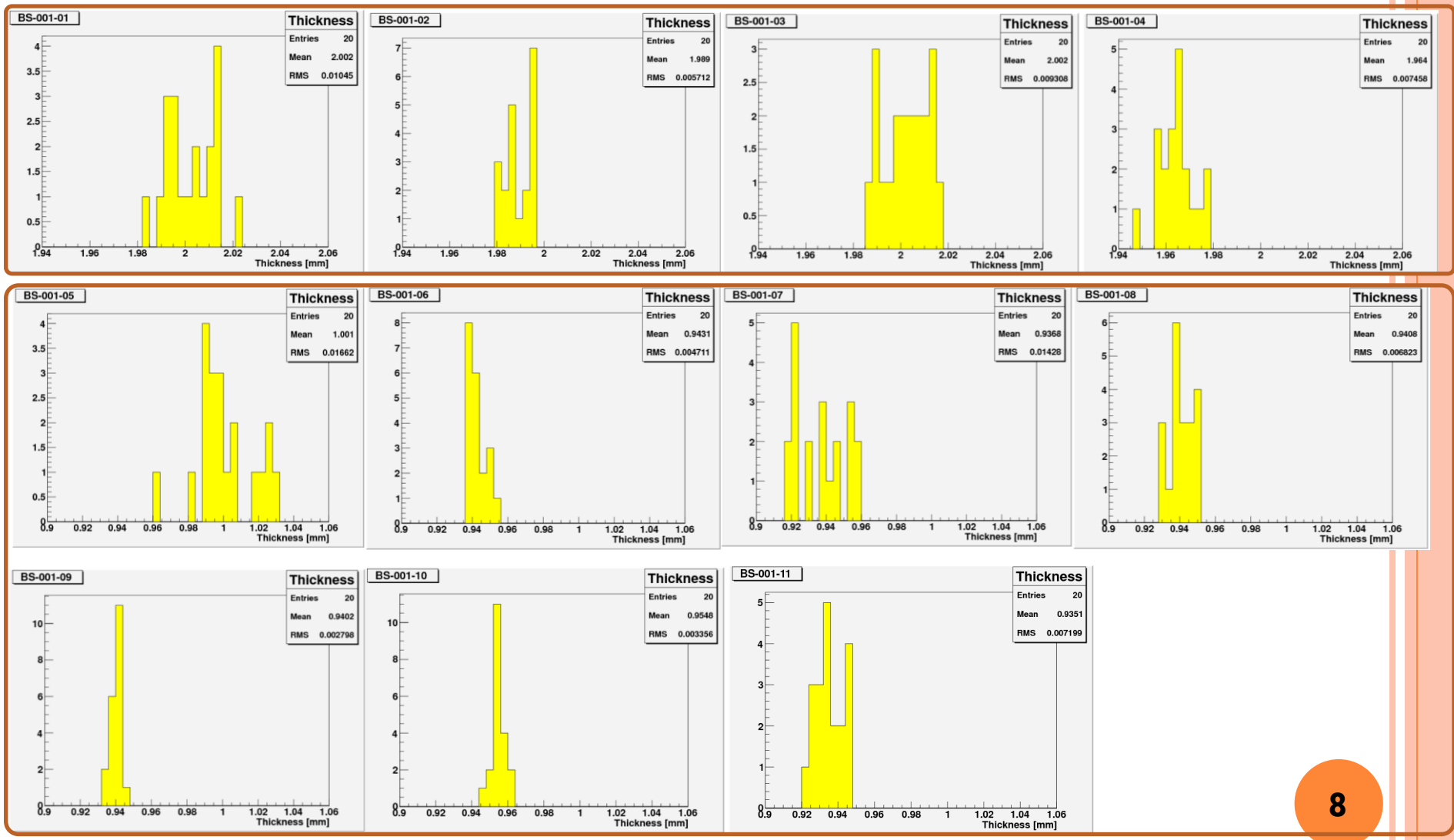
- 11 sample received from

Su MinFa @ June,17th 2011

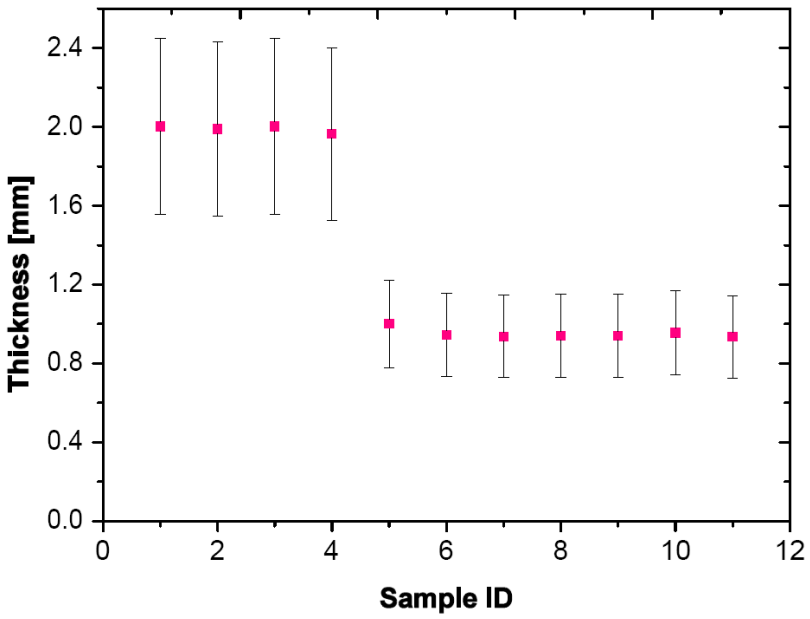
- Phenolic plate with two melamine surfaces
- 4 of the samples are ~2mm thick.
- Other 7 samples are ~1mm thick.
- Small size: 10 cm×10 cm
- 2 two of the samples have brown color
- Samples are numbered

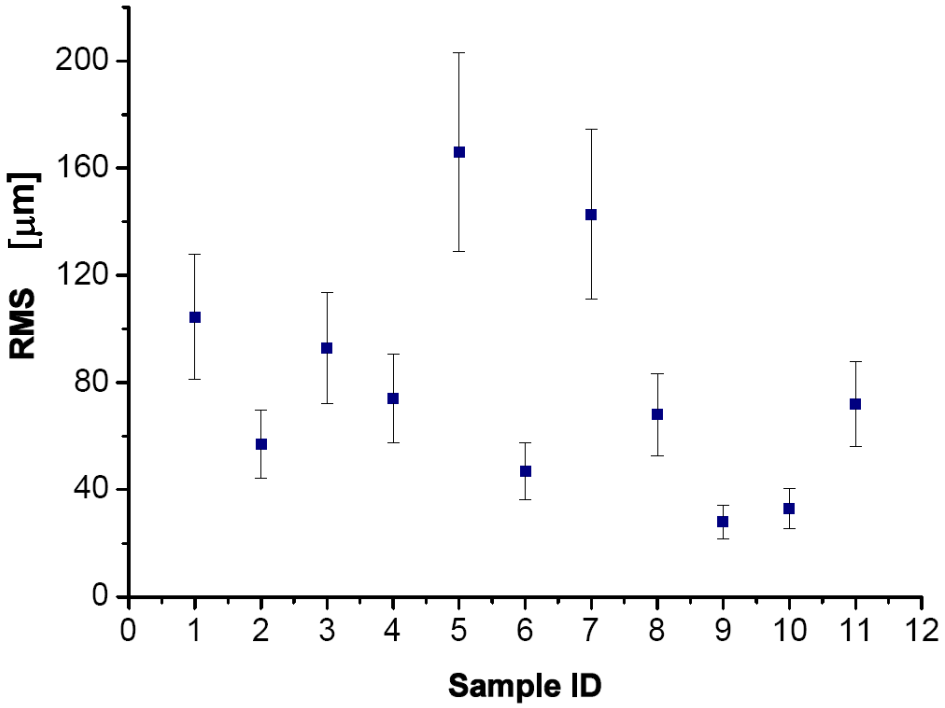
BS-XXX-XX

Thickness (1)

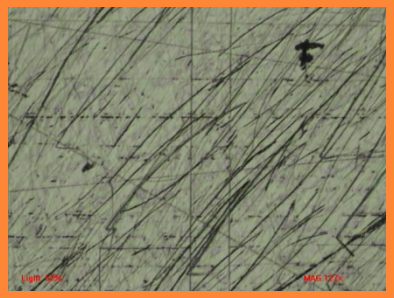
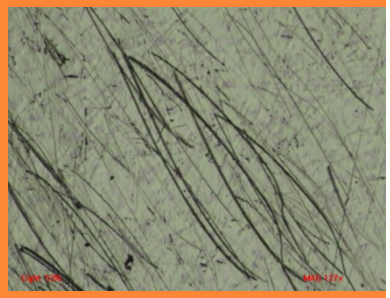
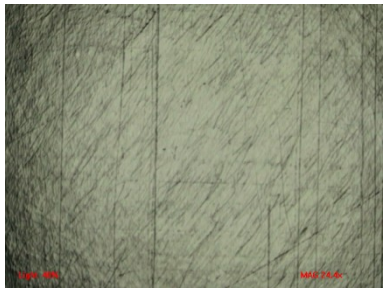
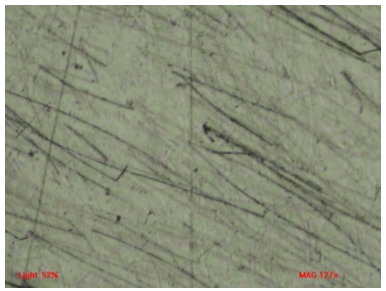
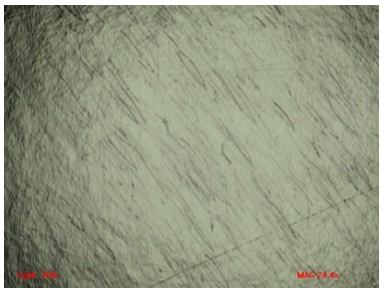
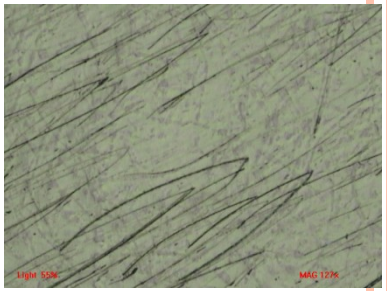
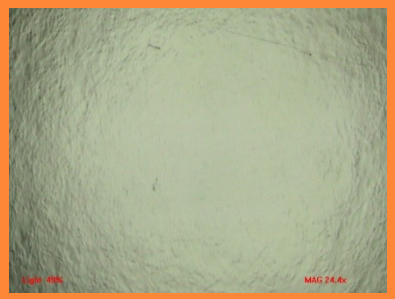
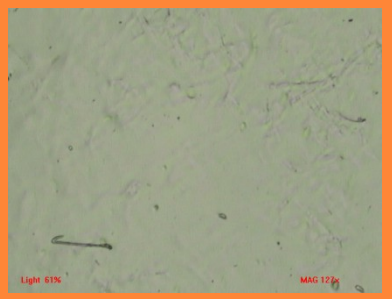
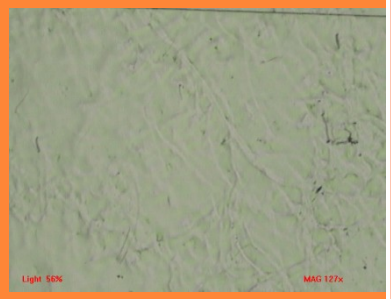

BS-001-01
Thickness
Entries 20
Mean 2.002
RMS 0.01045
BS-001-02
Thickness
Entries 20
Mean 1.989
RMS 0.005712
BS-001-03
Thickness
Entries 20
Mean 2.002
RMS 0.009308
BS-001-04
Thickness
Entries 20
Mean 1.964
RMS 0.007458
BS-001-05
Thickness
Entries 20
Mean 1.001
RMS 0.01662
BS-001-06
Thickness
Entries 20
Mean 0.9431
RMS 0.004711
BS-001-07
Thickness
Entries 20
Mean 0.9368
RMS 0.01428
BS-001-08
Thickness
Entries 20
Mean 0.9408
RMS 0.006823
BS-001-09
Thickness
Entries 20
Mean 0.9402
RMS 0.002798
BS-001-10
Thickness
Entries 20
Mean 0.9548
RMS 0.003356
BS-001-11
Thickness
Entries 20
Mean 0.9351
RMS 0.007199
Thickness [mm]

Thickness (2)

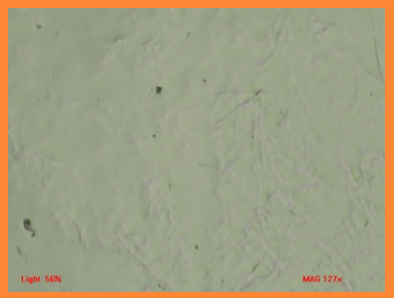
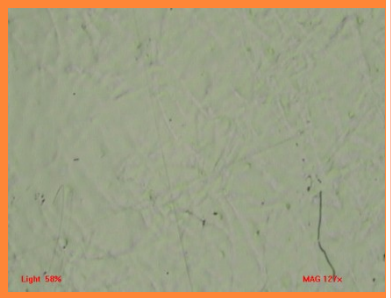
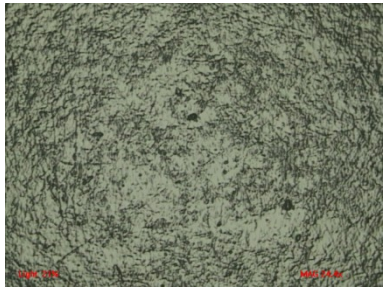
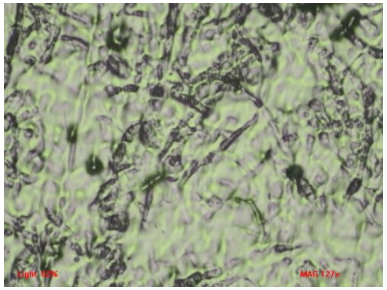
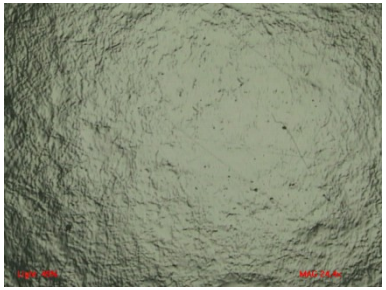
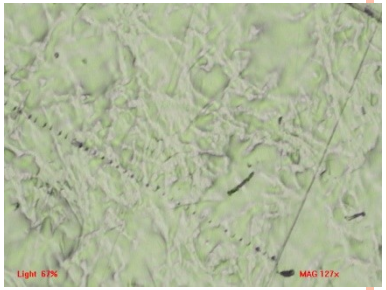
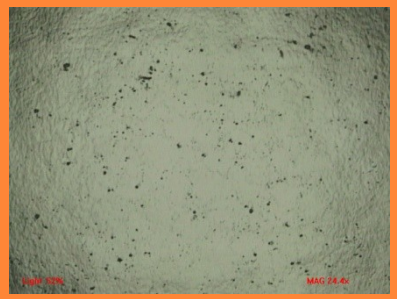
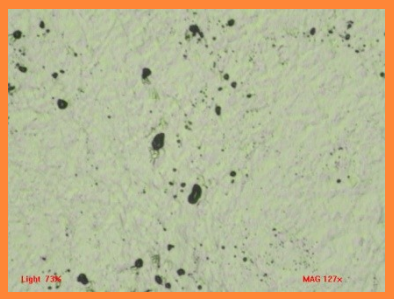
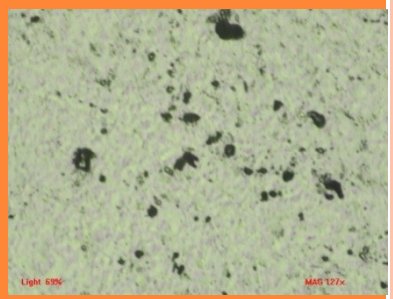

Thickness [mm]
2.4
2.0
1.6
1.2
0.8
0.4
0.0
0
2
4
6
8
10
12
Sample ID


RMS [µm]
200
160
120
80
40
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Sample ID

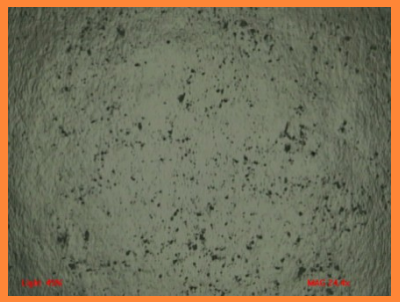
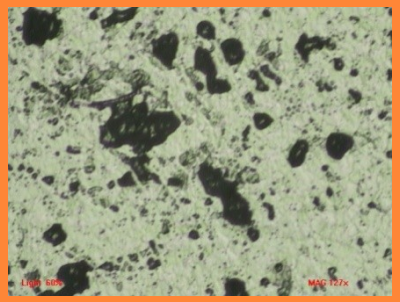
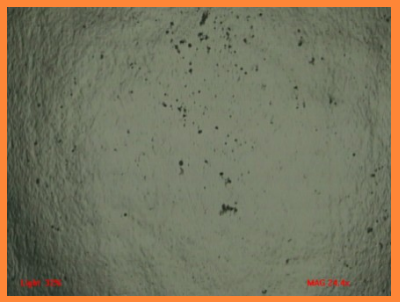
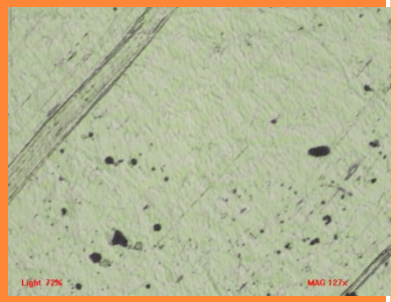
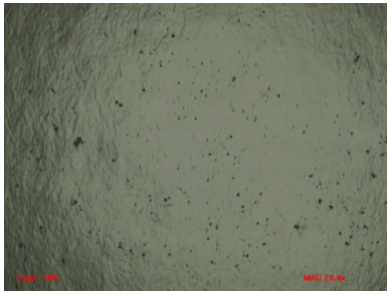
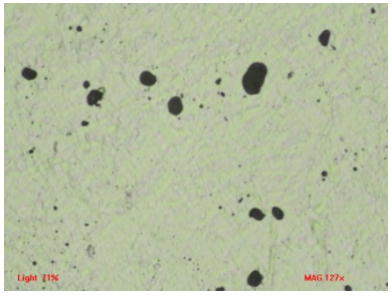
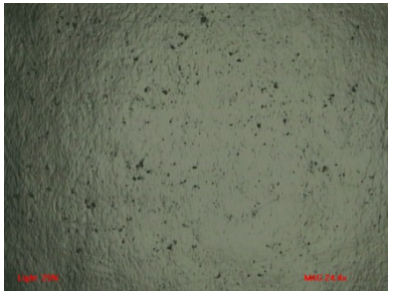
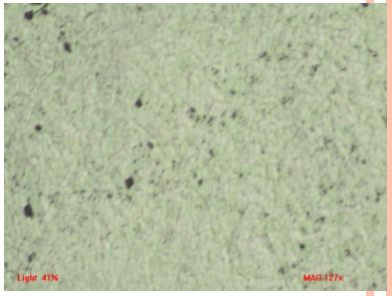
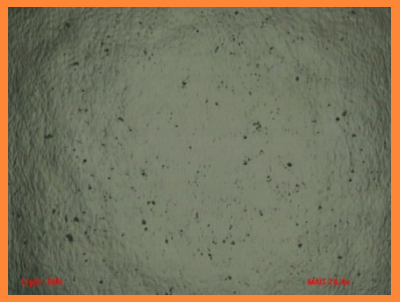
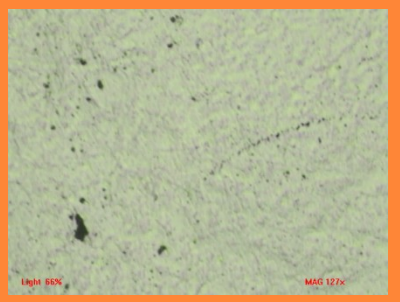
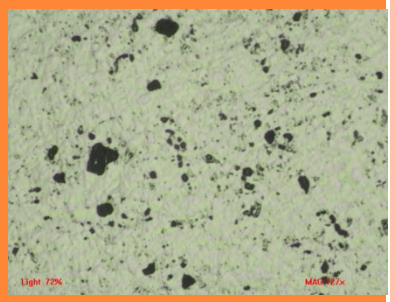
Surface condition (1)

ID	Side A Mag.×24	Side A Mag.×127	Side B Mag.×24	Side B Mag.×127
BS-001-01				
BS-001-02				
BS-001-03				

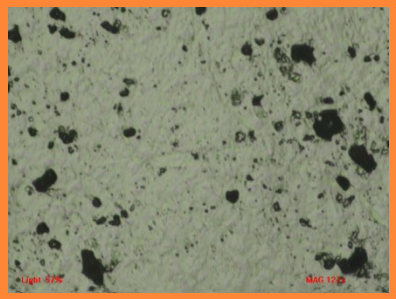
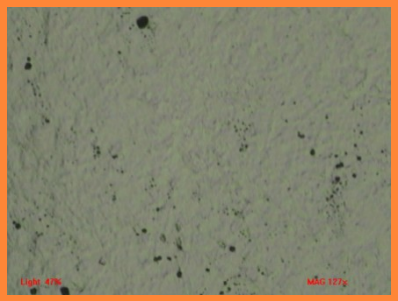
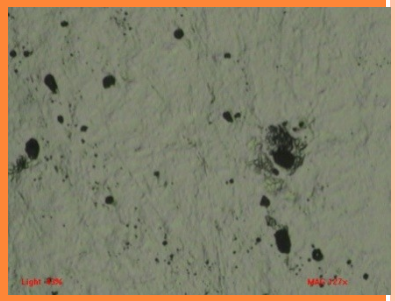
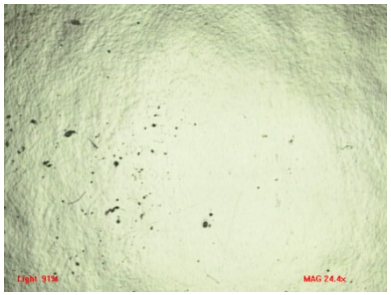
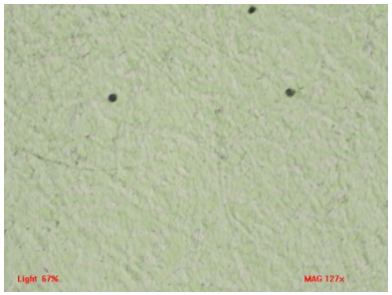
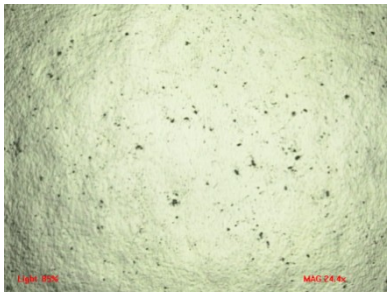
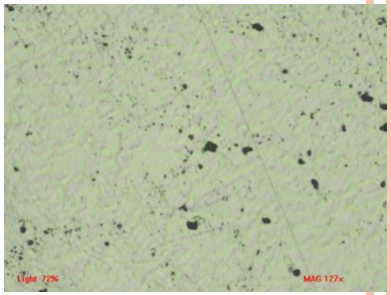
Surface condition (2)

ID	Side A Mag.×24	Side A Mag.×127	Side B Mag.×24	Side B Mag.×127
BS-001-04				
BS-001-05				
BS-001-06				

Surface condition (3)

ID	Side A Mag.×24	Side A Mag.×127	Side B Mag.×24	Side B Mag.×127
BS-001-07				
BS-001-08				
BS-001-09				

Surface condition (4)

ID	Side A Mag.×24	Side A Mag.×127	Side B Mag.×24	Side B Mag.×127
BS-001-10				
BS-001-11				

Bulk resistivity (1)

- BS-001-01 sample is tested with
  - different methods (use sample resistor, Pico ammeter)

- *Pico ammeter calibration test: 3.075 MΩ → test value: 3.2 MΩ*
- *Comparison of measured resistivity: (use carbon film as electrodes, T=23.5C, RH:40%)*

		A_{eff} [cm^2]	Current [A]	ρ [Ω·cm]	Charging time
Sample resistor	10 kΩ	40.95	1.9×10^{-6}	5.4×10^{10}	~ 2 h
	3 *MΩ*	40.95	1.47×10^{-6}	6.96×10^{10}	~ 2min
Pico ammeter		40.95	1.4×10^{-6}	7.3×10^{10}	~ 35 min

Bulk resistivity (2)

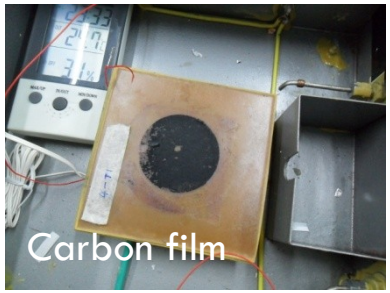
- different test electrode sizes

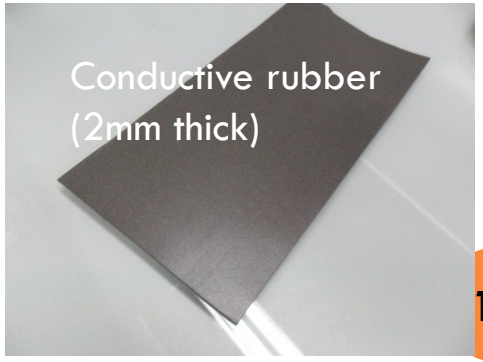
A_{eff} [cm^2]	Current [A]	ρ [Ω·cm]	Charging time	T [C]	RH [%]
40.95	1.4×10^{-6}	7.3×10^{10}	~ 35 min	23.5	40
19.6	1.2×10^{-6}	4.1×10^{10}	~2 min	26	34

Note that the difference of the measured bulk resistivity value comes from the temperature difference, resistivity non-uniformity and charging time. But they still on the same order in the room temperature range (24-26 C)

- different electrodes
  - *Carbon film:**(merit ☺)**very good contact with sample material, no pressure needed, reasonable measurement repeatability, **(demerit ☹)** hard to peel off from sample*
  - *Conductive rubber: sensitive to pressure*

3atm pressure is applied on test electrode for CMS Bakelite resistivity measurement
→ this means 64 kg weight on our ~20cm^2 test electrode
45 kg weight on electrode tested, only get 1/20 of the current compared with the value obtained with carbon film electrode

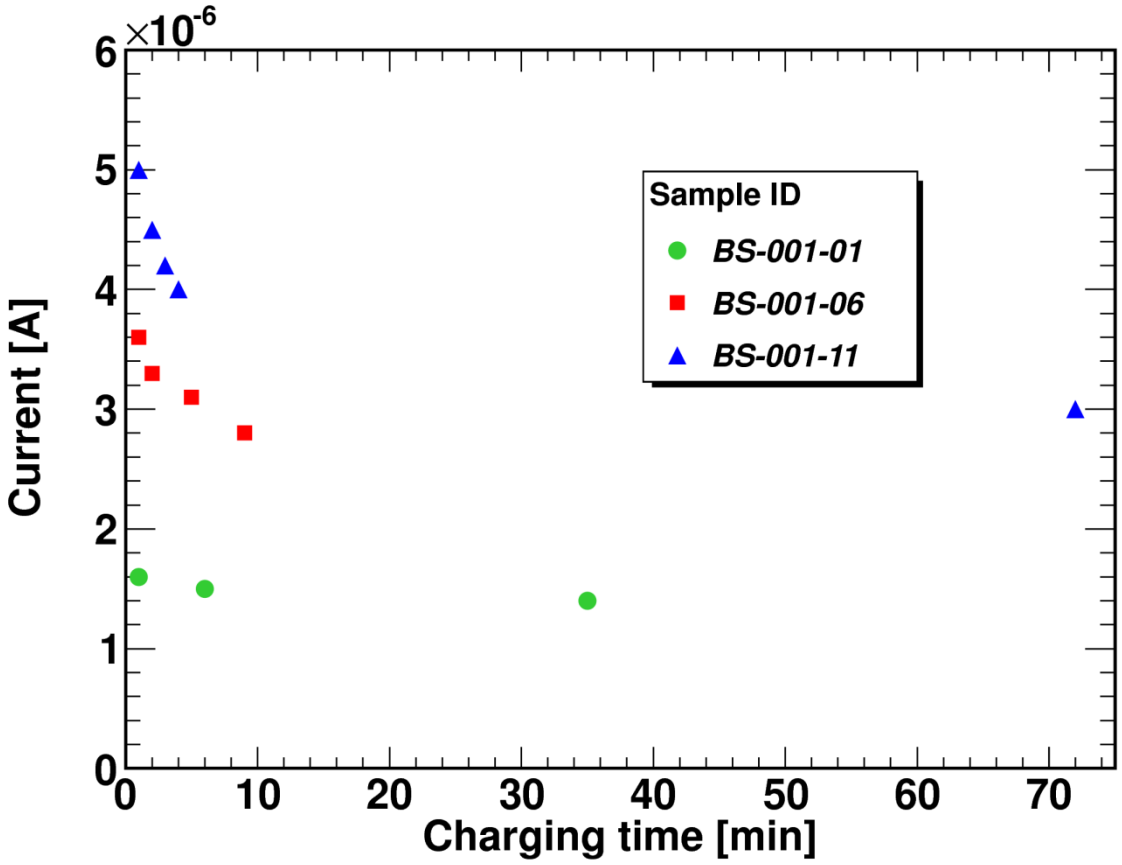




rubber filled with small conductive mental or carbon spheres

Bulk resistivity (3)

Current flowing through test plate as a function of charging time



Bulk resistivity (4)

Sample ID	Aeff [cm^2]	Thickness [cm]	Current [A]	Char. Time [min]	ρ [Ω·cm]	Temp [C]	RH [%]
BS-001-01	40.95	0.2002	1.50E-06	6	**6.82E+10**	23.4	40
BS-001-02	26	0.189	8.60E-07	5	**8.00E+10**	25.9	33
BS-001-03	26	0.2002	8.40E-08	5	**7.73E+11**	25.9	34
BS-001-04	26	0.1964	8.40E-08	5	**7.88E+11**	25.8	34
BS-001-05	26	0.1001	1.80E-05	7	**7.22E+09**	25.8	35
BS-001-06	26	0.09431	3.10E-06	5	**4.45E+10**	25.9	35
BS-001-07	26	0.09368	4.50E-06	5	**3.08E+10**	25.6	36
BS-001-08	26	0.09408	3.60E-06	5	**3.84E+10**	25.9	33
BS-001-09	26	0.09402	2.40E-06	5	**5.76E+10**	25.6	36
BS-001-10	26	0.09548	3.00E-06	5	**4.538E+10**	25.6	34
BS-001-11	26	0.09351	4.00E-06	4	**3.476E+10**	25.4	34

* Measured with carbon film electrodes for shot time

Summary & Outlook

- Only one sample (BS-001-05) has the resistivity value in our interest range (<10^9 Ω·cm) but **Poor** surface condition and **Poor** thickness uniformity
- Strong dependence of bulk resistivity on temperature. Need further tests with each sample
- Humidity study?
- Charging time curve not very similar from sample to sample. Need further study. (30 min charging time seems OK for quick reference)