Burn-in & Test Socket Workshop

March 6-9, 2005
Hilton Phoenix East / Mesa Hotel
Mesa, Arizona

ARCHIVE

Burn-in & Test Socket Workshop™

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Burn-in & Test Socket Workshop

Technical Program

Hot Topics Session
Tuesday 3/08/05 3:30PM

CONTROLLING ESD

"Methods Of Preventing ESD In Module Testing"

Zen Podpora – IBM Microelectronics

Qifang (Michelle) Qiao – IBM Microelectronics **Patrick Rafter** – IBM Microelectronics

"New ESD Control Polymers"

Naomitsu Nishihata – Kureha Chemical Industry Co., Ltd.

METHODS OF PREVENTING ESD IN MODULE TESTING

2005 Burn-in and Test Socket Workshop

Zen Podpora
Michelle Qiao
Patrick Rafter

Contacting Systems Engineering
IBM Microelectronics

Objectives

- ESD overview
- Impact of ESD on module test
- Methods of ESD prevention

Agenda

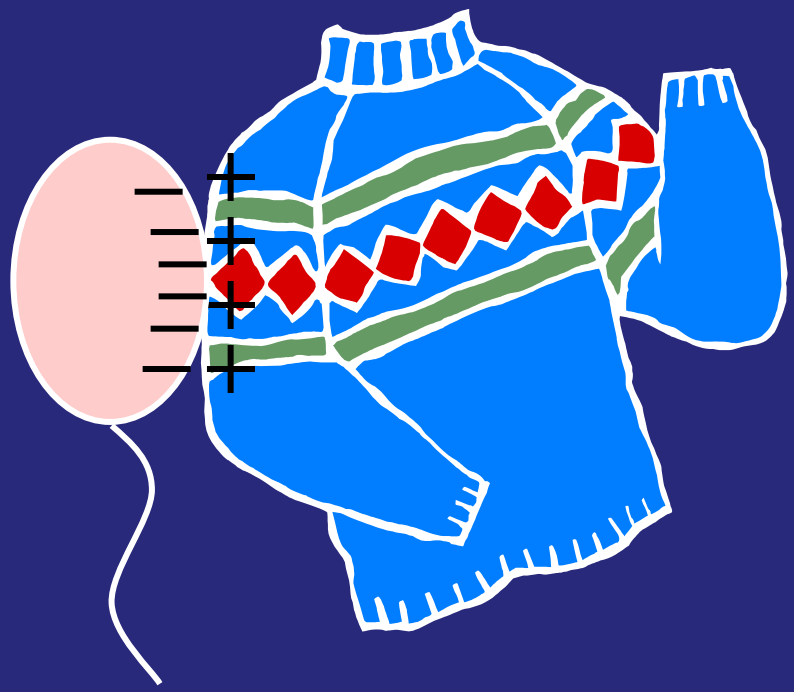
- What is static electricity
- Causes of static charge buildup
- Impact of ESD on product and test equipment
- Conventional ESD prevention methods and their deficiencies
- IBM ESD socket design

What is Static Electricity?

- **Simply electricity at rest**
  - **No current flowing**
- **Surface phenomenon**
  - **Static charge is dependent on surface area**
- **Coulomb's law; $F = k (Q_1 X Q_2) / d^2$**
  - **Electric force between charges at rest**

Static Charge Buildup

- **Electric phenomenon in which intimate contact transfers charged particles from one body to another**

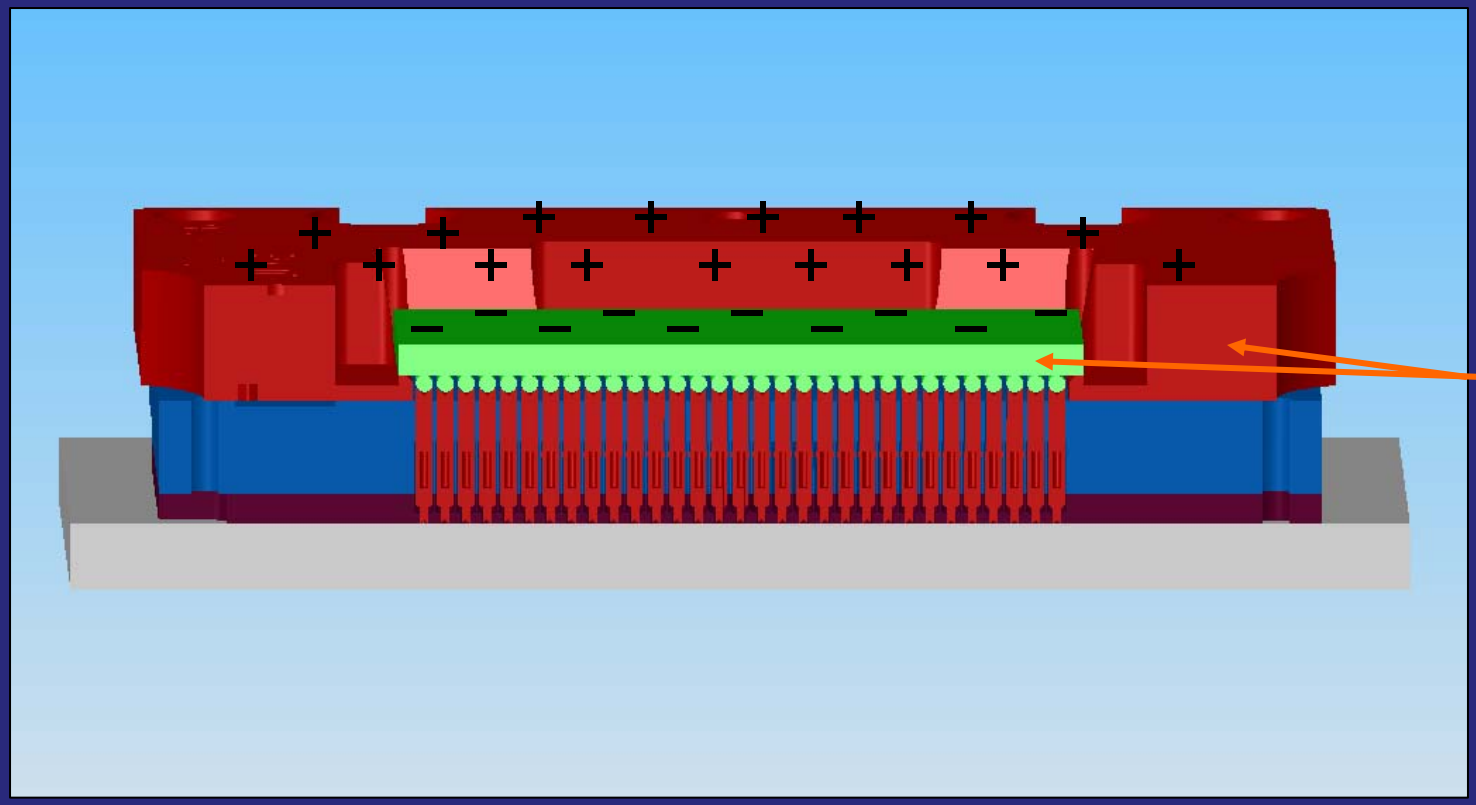


Rubbing two non conducting materials together

Static Charge Buildup

- **Only insulative materials build up static charge**
  - **Insulative material surface resistivity > 10^{12} ohms / sq**
- **Socket components comprise insulative materials**
  - **Static charge build up from module insertion into socket**

Static Charge Buildup in Socket



Electrostatic charge build up during module insertion

Electrostatic Discharge [ESD]

- **Common ESD events**
  - **Lightning**
  - **Walk across the rug and reach doorknob**
- **Module test events**
  - **Charged operator reaching IC module**
  - **Charged socket discharging thru the tester**

Discharge of build up of static electricity

Common Causes of ESD Damage

- **Human Body Model (HBM) <0.10%**
  - **Improper grounding**
  - **Faulty personal protective equipment**
  - **Not following ESD procedures**
- **Charged Device Module (CDM) >99.9%**
  - **ESDS transportation**
  - **Air blow-off operations**
  - **IC handling equipment**

Impact of ESD

- Electrostatic Discharge (ESD) destroys electronic hardware
  - Immediate failures - distractive damage
    - Direct-current resulting in junction burnout, shorts, dielectric breakdown, and metallization melt
  - Latent failures (field failures), days, weeks, months later
- ESD creates problems which cost industry billions of dollars per year

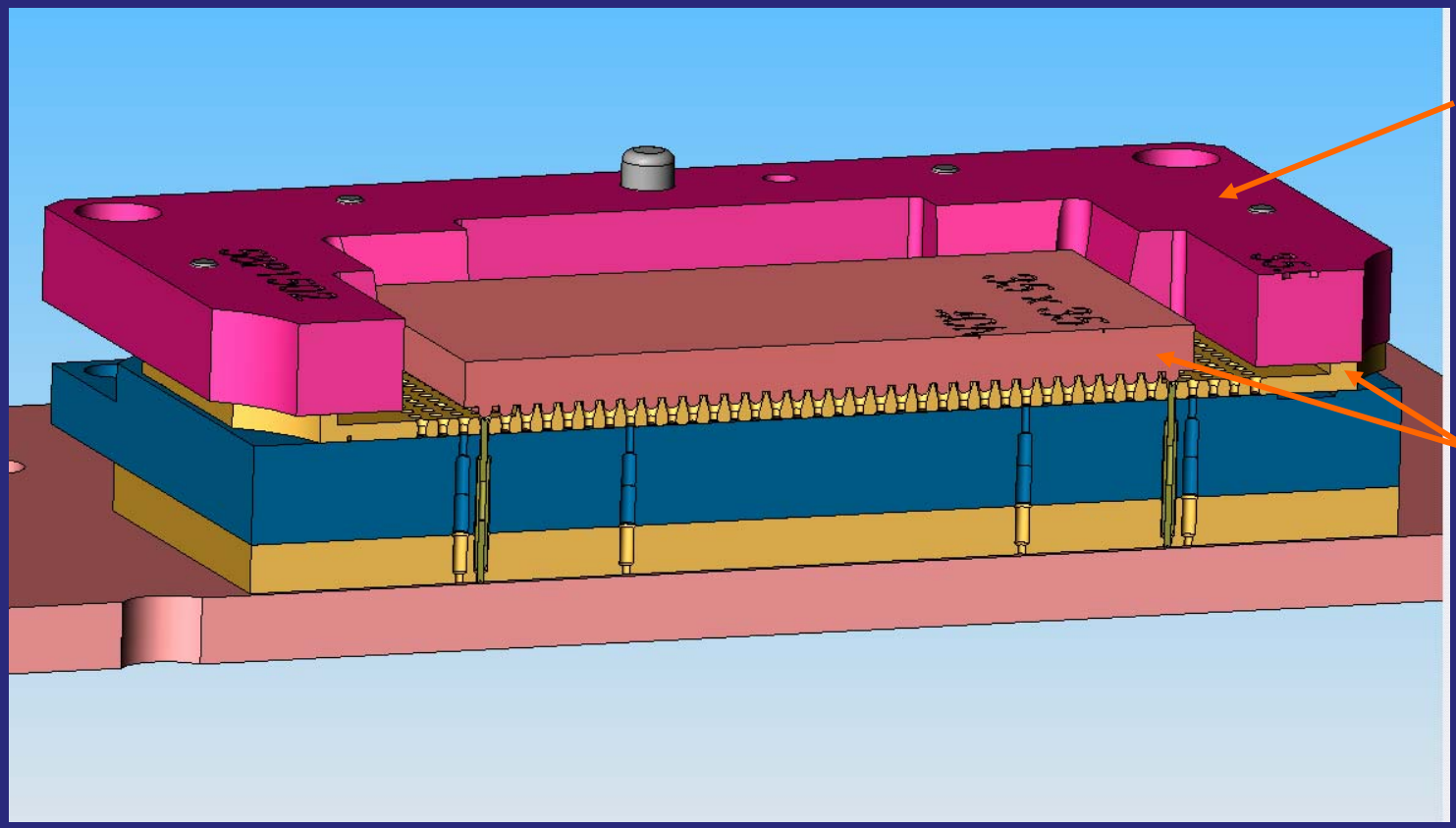
Conventional ESD Prevention

- Grounding
  - Personnel
  - Equipment
- Ionization
  - Ionizing units neutralize charged particles
- Use of resistive materials
  - Surface resistivity 10^6<->10^9 ohms (carbon mix)
- Humidity control
  - Relative humidity greater than 50% will minimize ESD problems

Problems with Conventional ESD Prevention

- Resistive materials
  - Non uniform carbon distribution (hot pockets)
  - Leakage currents
- Humidity control
  - Condensation problem at low temp test
- Grounding
  - Operators bypass ESD procedures

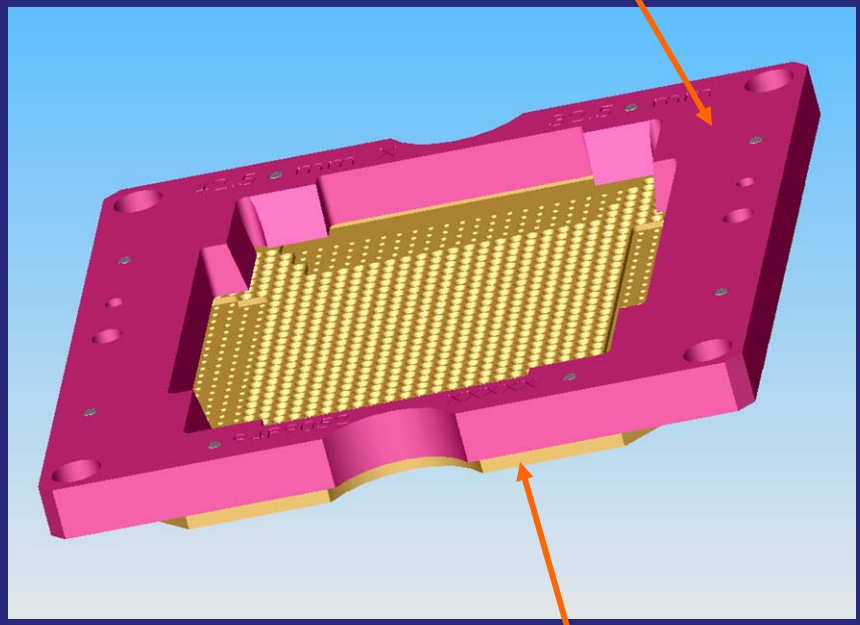
IBM ESD Socket



No static charge buildup at module insertion

IBM ESD Socket

- Alignment plate frame
  - Made from conductive material [< 10^4 ohms/sq]
  - Will not store electric charge
- Alignment plate grid
  - Made from insulative material [> 10^{12} ohms/sq]
  - Will not cause leakage currents



ESD Facts

- CMOS chips damage <> as little as 50V
- If you feel a ‘shock’ <> at least 3kV
- Walking across a carpet <> 1.5kV to 35kV
- Brushing your hair <> 1.2kV to 27kV

- Not getting ZAPPED <> priceless

Reference Materials

- **Basics of Static Electricity** by Ron Kurtus (revised 28 August 2004
  - www.school-for-champions.com
- **The Most Common Causes Of ESD Damage** by Roger J. Peirce, ESD Technical Services
  - http://www.evaluationengineering.com/default.asp
- **WHAT IS STATIC ELECTRICITY?** by SCIENCE MADE SIMPLE
  - http://www.sciencemadesimple.com/index.html
- **What is ESD ?** By Research Machines plc
  - http://www.rm.com/
- **ESD Is Shocking Experience for Electronics** by Ron Brewer, Instrument Specialties, P.O. Box 650, Delaware Water Gap, PA 18327, (570) 424-8510.

New ESD Control Polymers

Naomitsu Nishihata

Kureha Chemical Industry Co., Ltd.

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Agenda

- What is ESD
- Material for socket
- Technology review
- New technology
- Sample preparation
- Characterization
- Conclusion

What is ESD

An ESD occurrence requires all three events:

- **Charge generation**
- **Charge accumulation**
- **Rapid discharge**

What is ESD

- Human Body Model: Discharged from operators
- Charged Device Model: Device charged up and pins contact ground.
- Machine Model: Discharge from machine members

Material for socket

- Temperature considerations
  - Test: -55°C to 150°C?
- Machinability
- Leakage current threshold
- ESD control properties
  - 10^6-10^{11} ohms/sq.
  - Strictly controlled resistance
- Cleanliness
  - Low out-gassing
  - Low metal contamination
- Wear properties

Technology review of materials

Conventional Materials

- Carbon material-filled compound
- Metal filled-compound
- Antistatic agent added polymer
- Antistatic polymer blend

Technology review of materials

Technology	ESD control properties	Cleanliness	Heat and chemical resistance
Carbon	Unstable	Good	Good
Metal	Unstable	Limited use	Good
Antistatic agent	Limited use	Poor	Poor
Antistatic polymer blend	Limited use	Limited use	Poor

New Technology

- Combine a special carbon material having moderately conductive resistance with a polymer.
- Optimize production process

Sample preparation

Raw Materials

- Polyetheretherketone resin (PEEK)
- Special carbon with resistivity of 10^7 10^8 and 10^9 ohms/sq.
- PAN-based carbon fiber

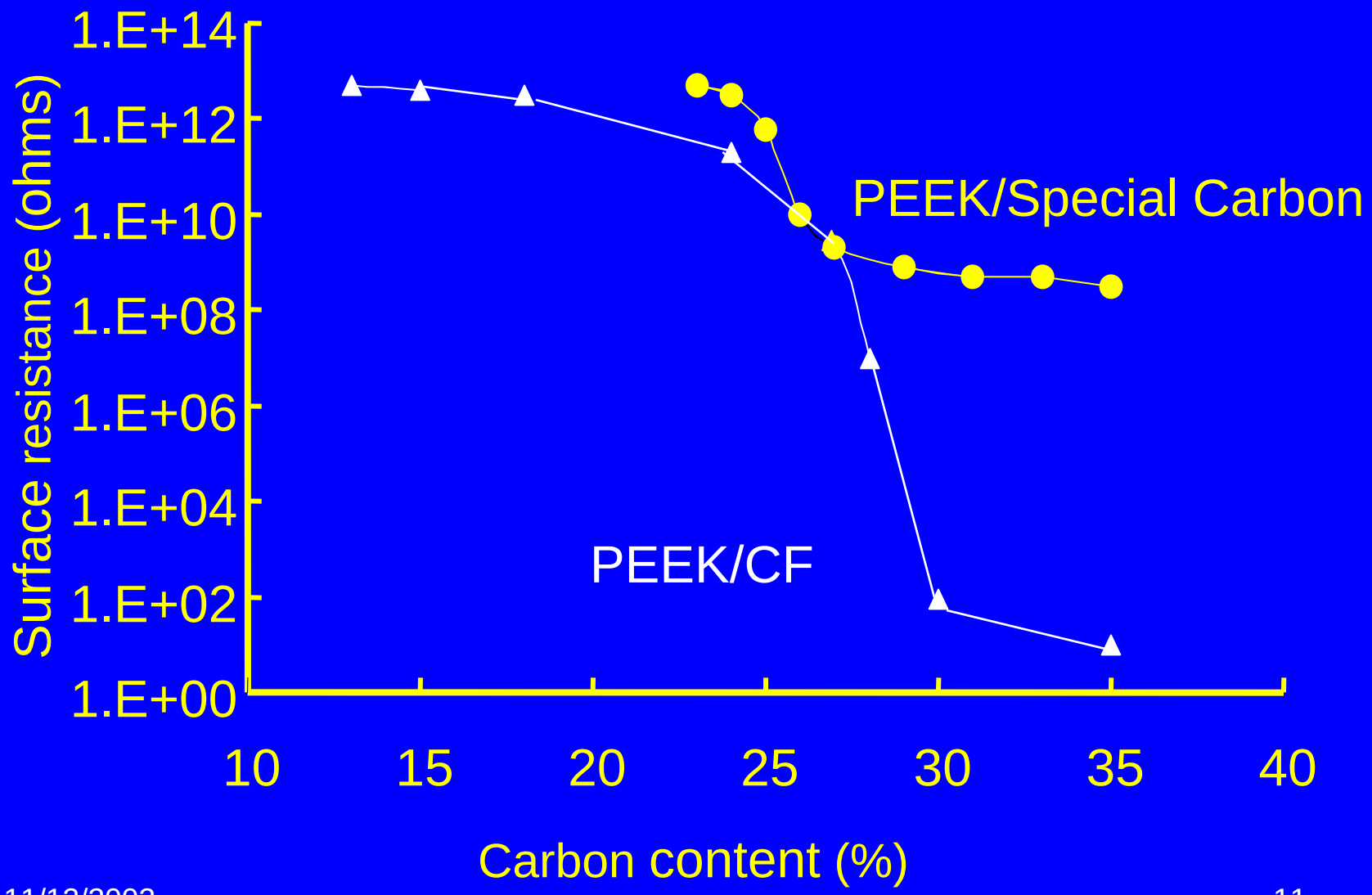
Procedure

- Raw material blend
- Extrusion
- Injection molding
- Characterization

Characterization

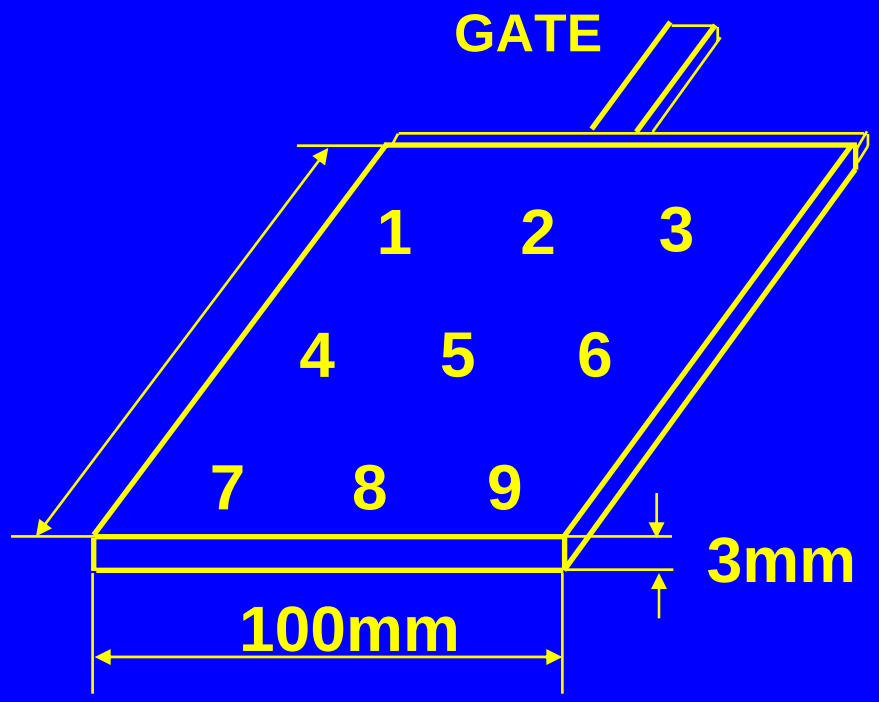
- Resistance vs carbon content
- Resistance fluctuation
- Resistance change against applied voltage
- Resistance of inner layer
- Static decay time vs resistance
- Residual peak voltage vs resistance
- Peak current analysis on ESD
- Leak current analysis of a socket
- Other properties

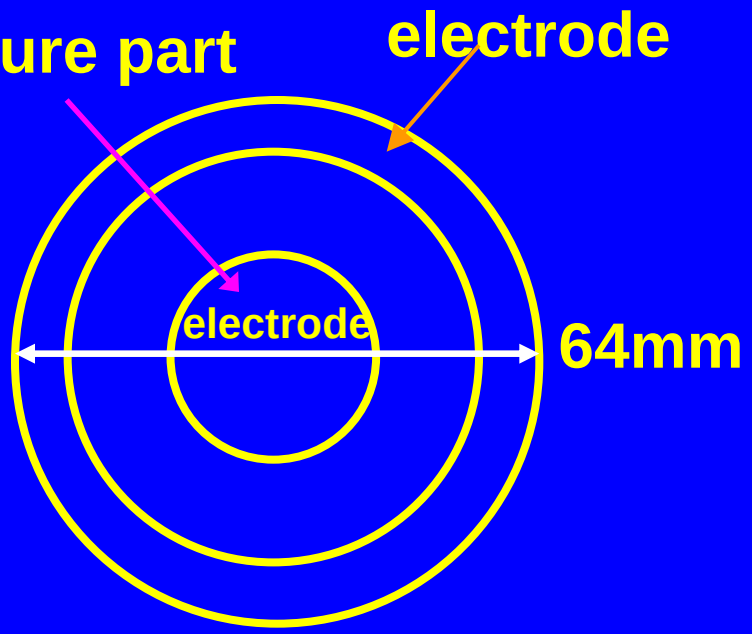
Resistance of Composites



Resistivity Fluctuation

Diameter of guide electrode : 9mm
Applied voltage : 10V, 100V, 500V

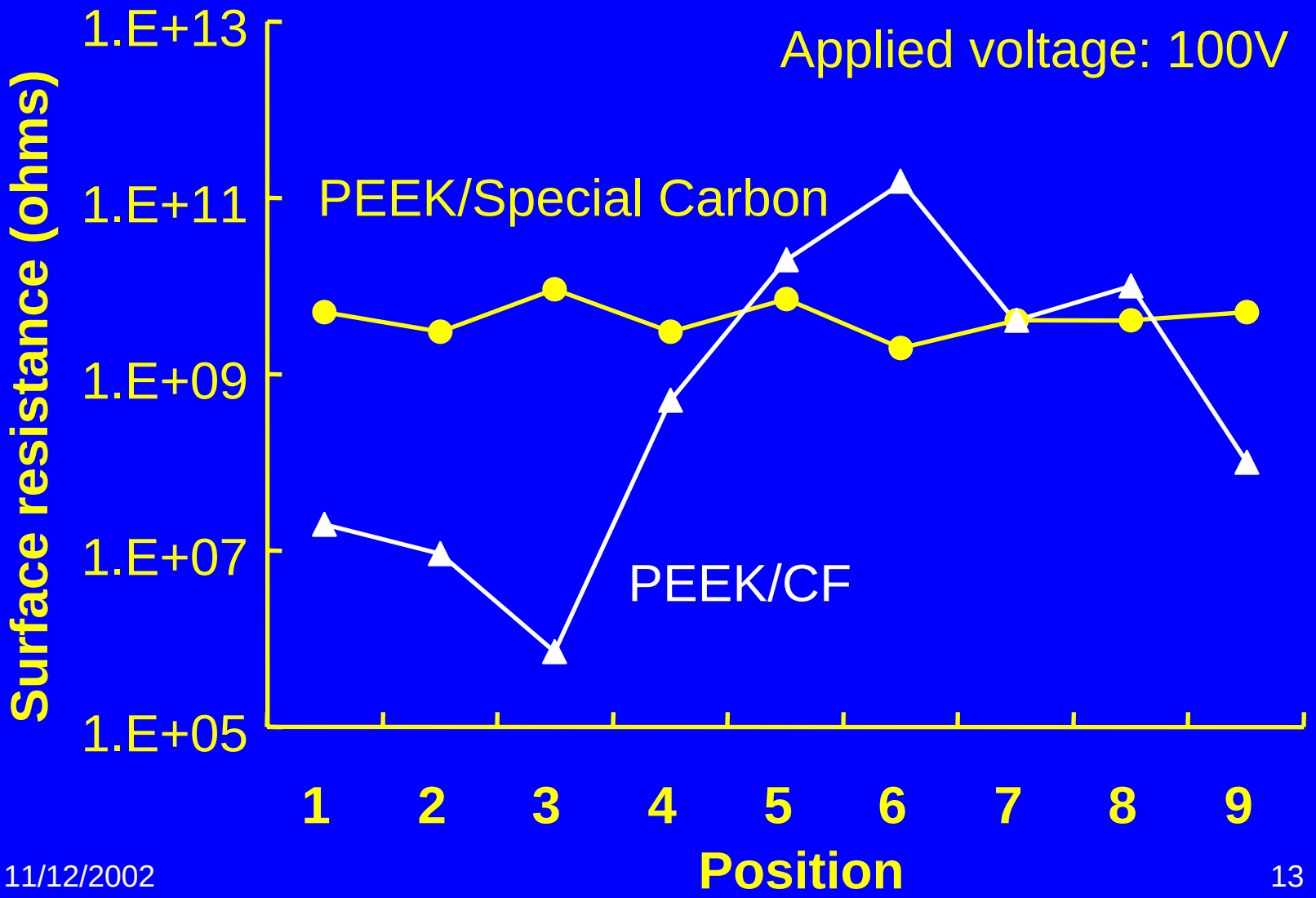




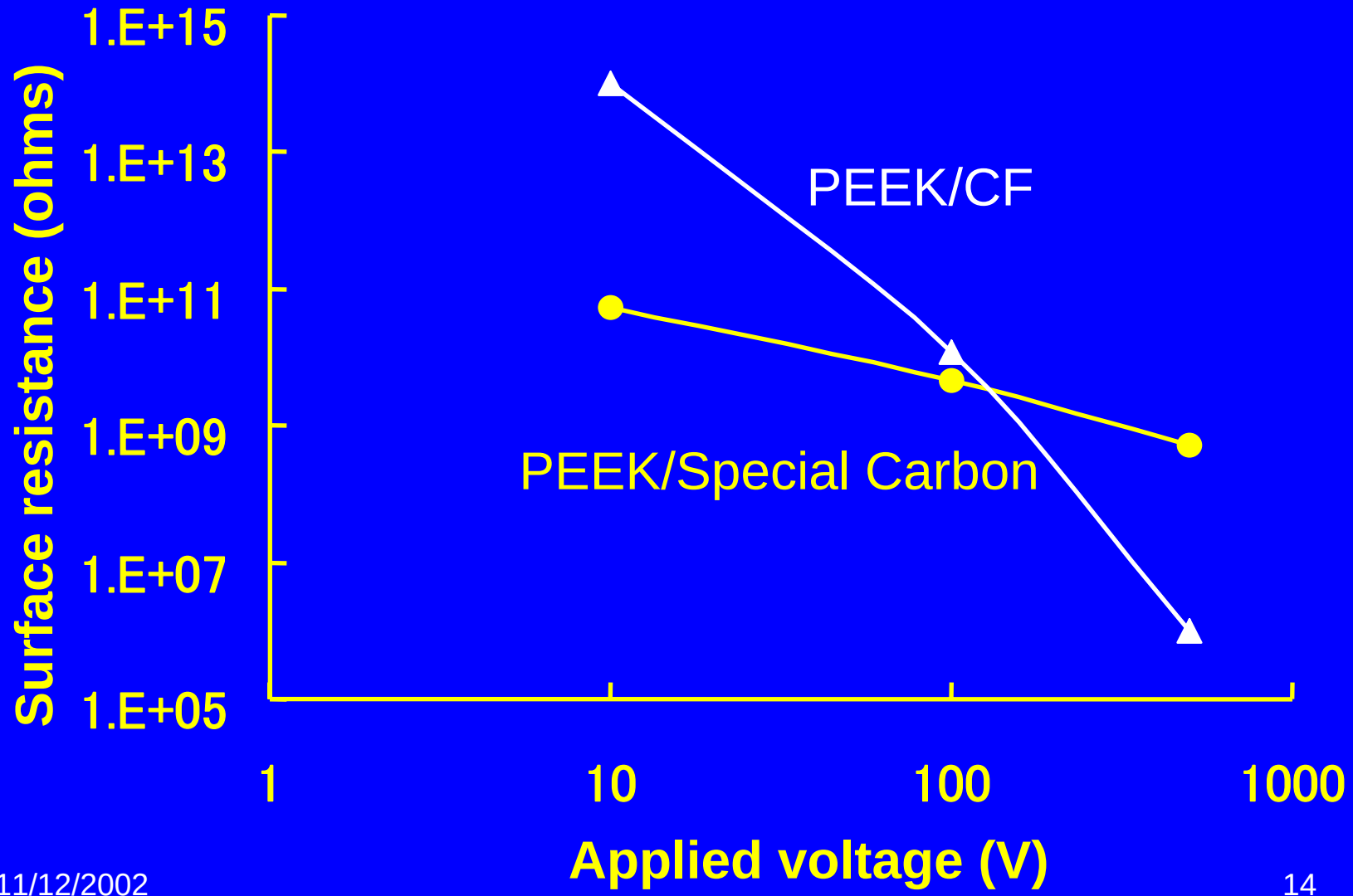
ESD-STM11.11

Small type

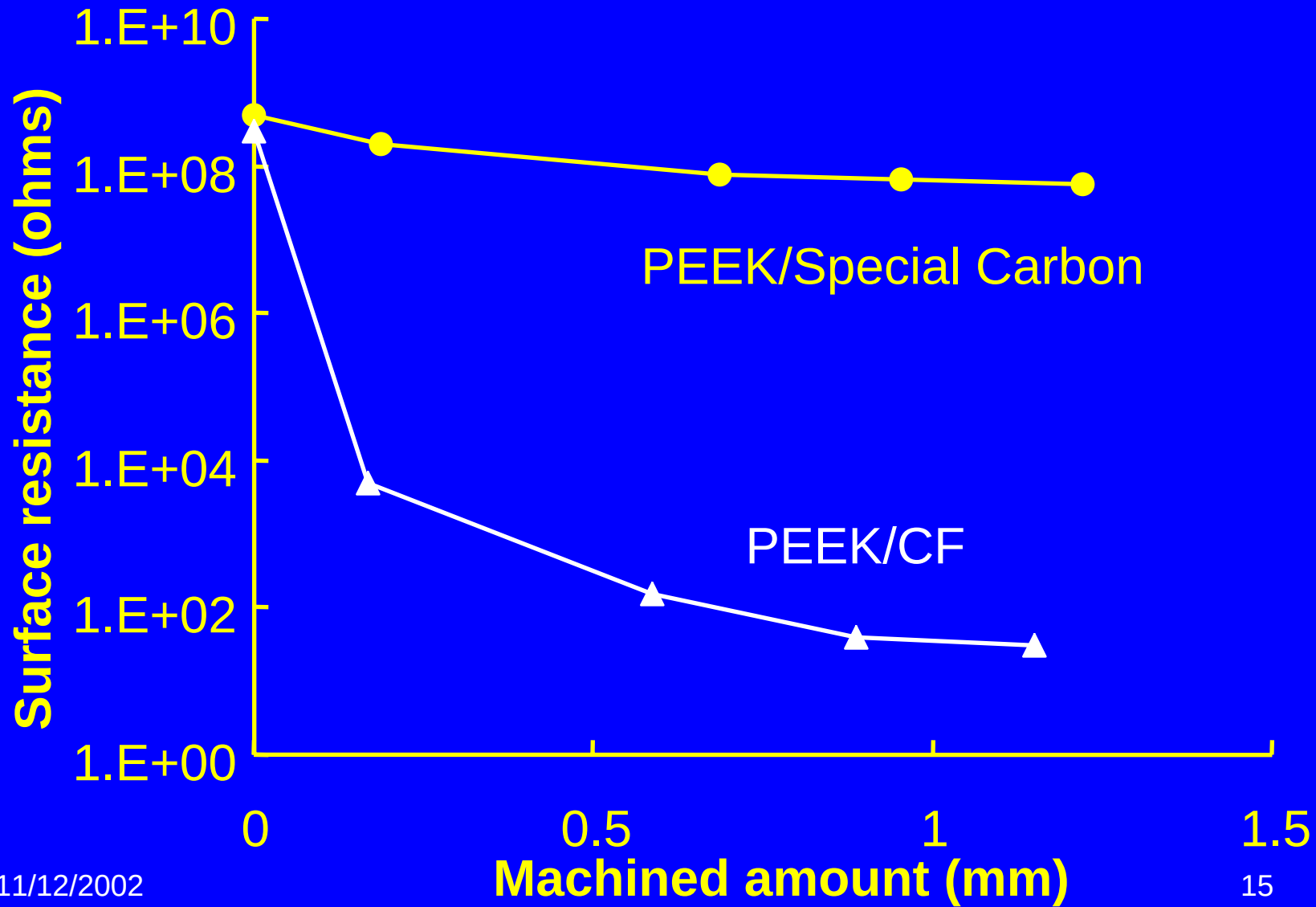
Resistivity Fluctuation



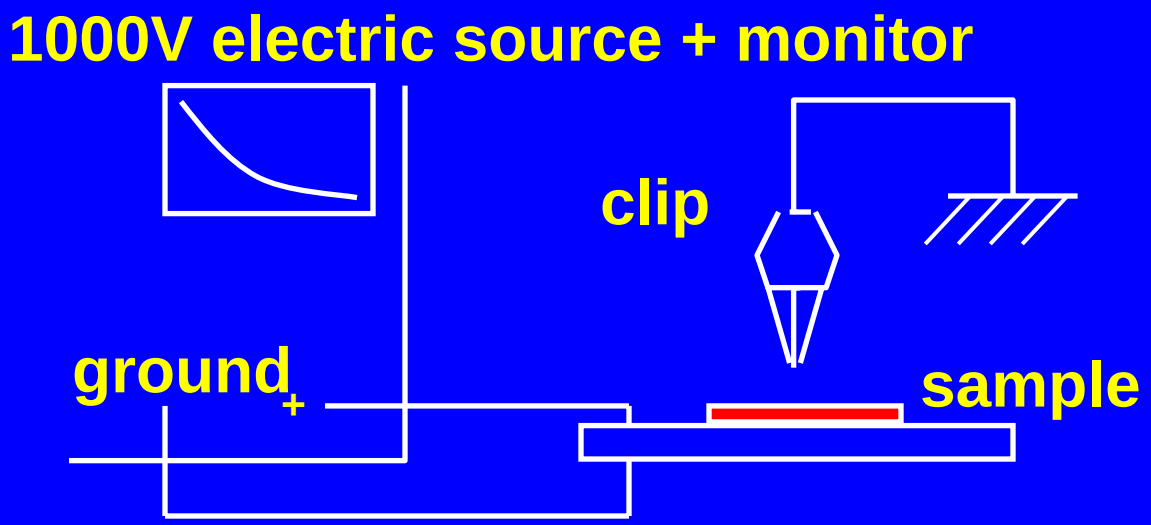
Resistivity vs Voltage



Resistivity of Inner Layer



Static decay time

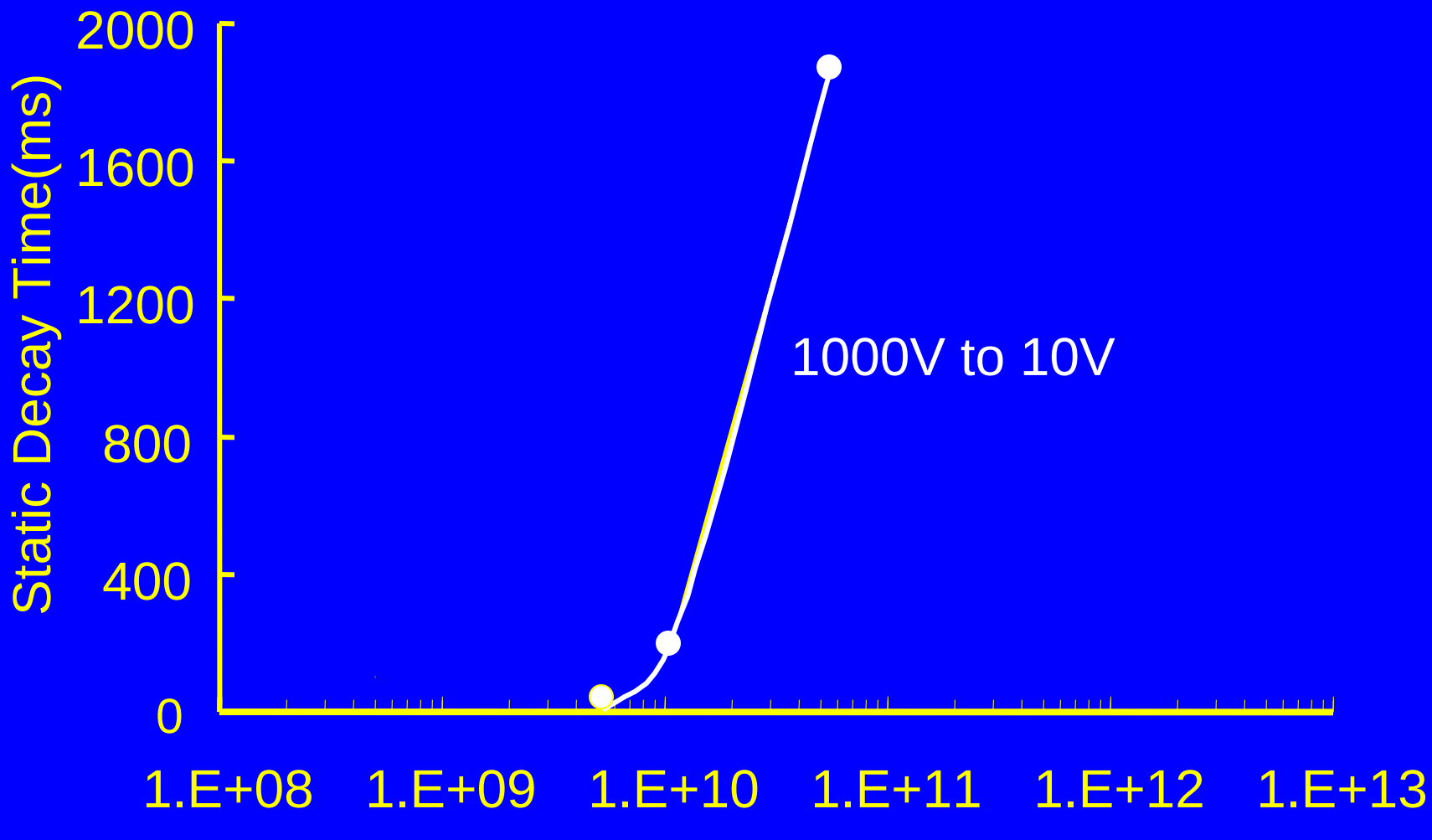


SDT measurement using Charged Plate Monitor

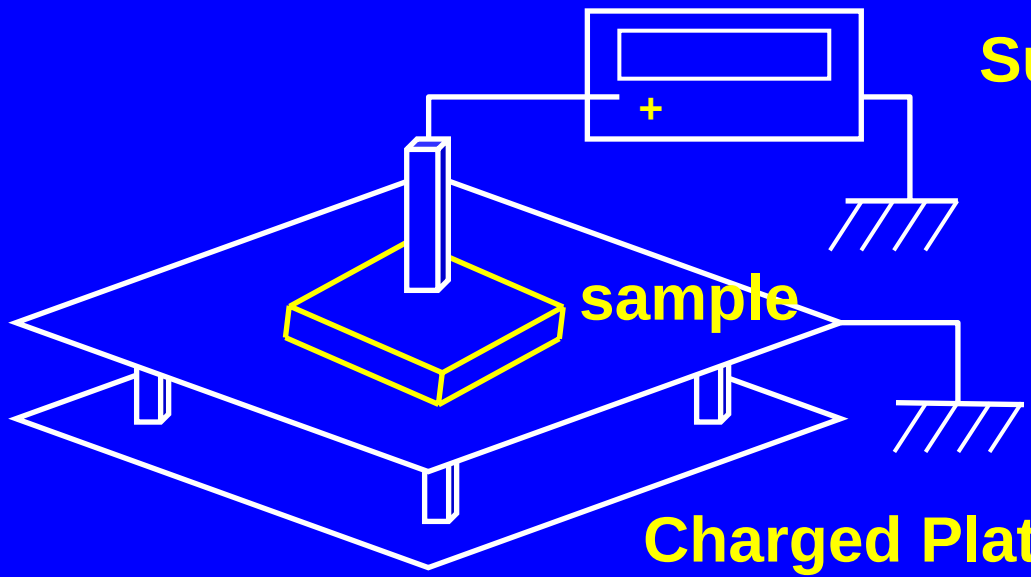
Static decay time

- The static decay time from 1000V to 5V was measured using charged-plate monitor.

Resistance vs Voltage



Hot spot voltage test



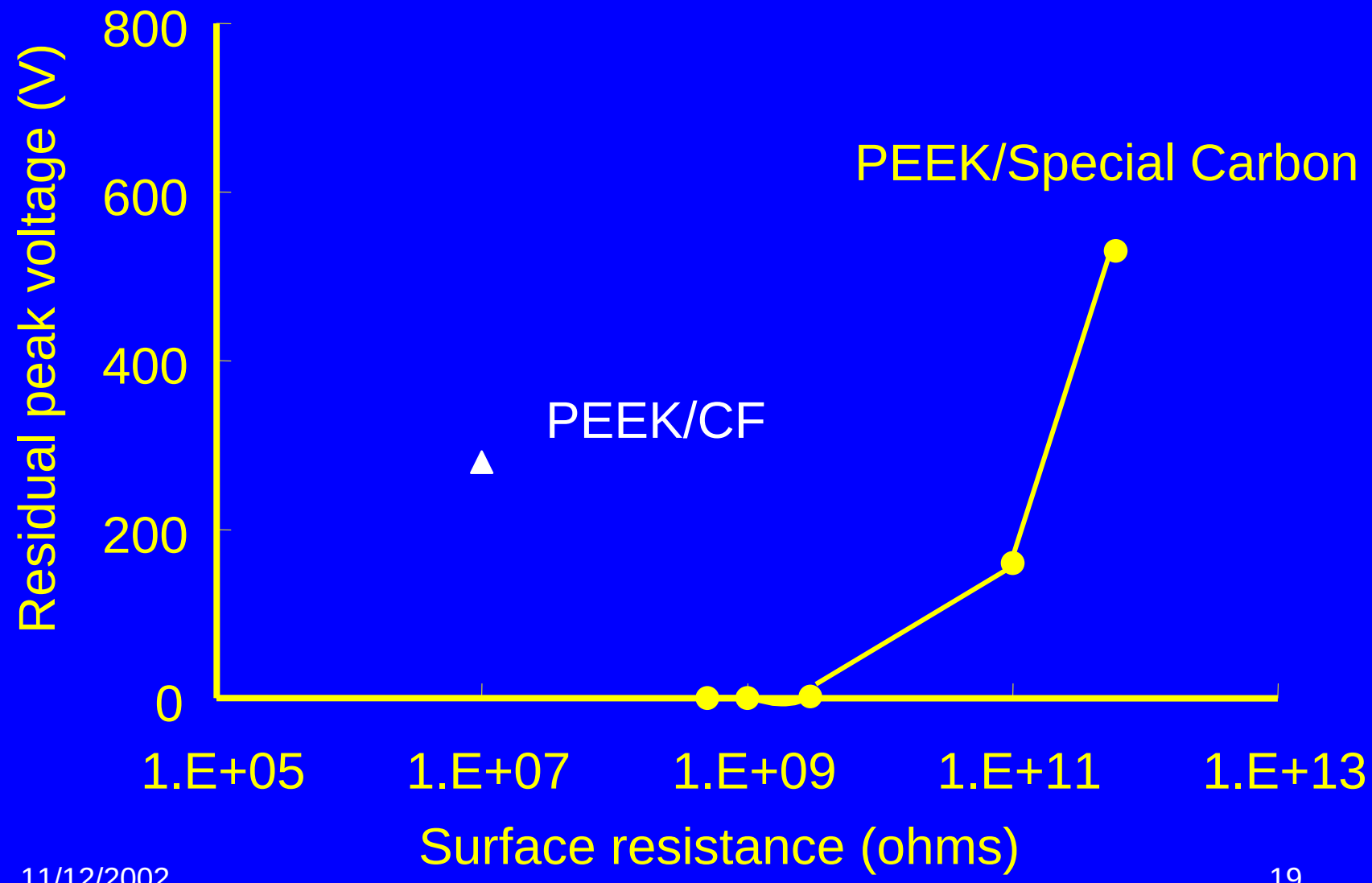
Surface electrometer

Charged Plate Monitor

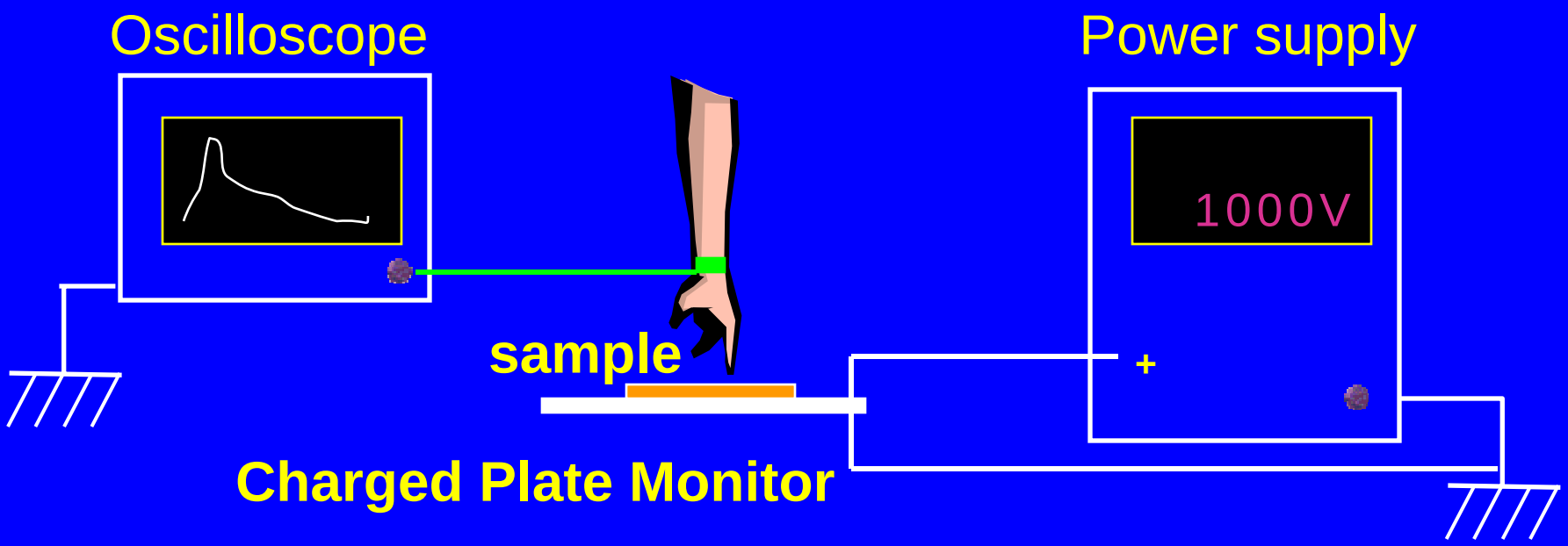
Hot spot voltage

- To search insulative spots on the surface
- To evaluate homogeneity by measuring residual voltage after discharging.

Hot spot voltage

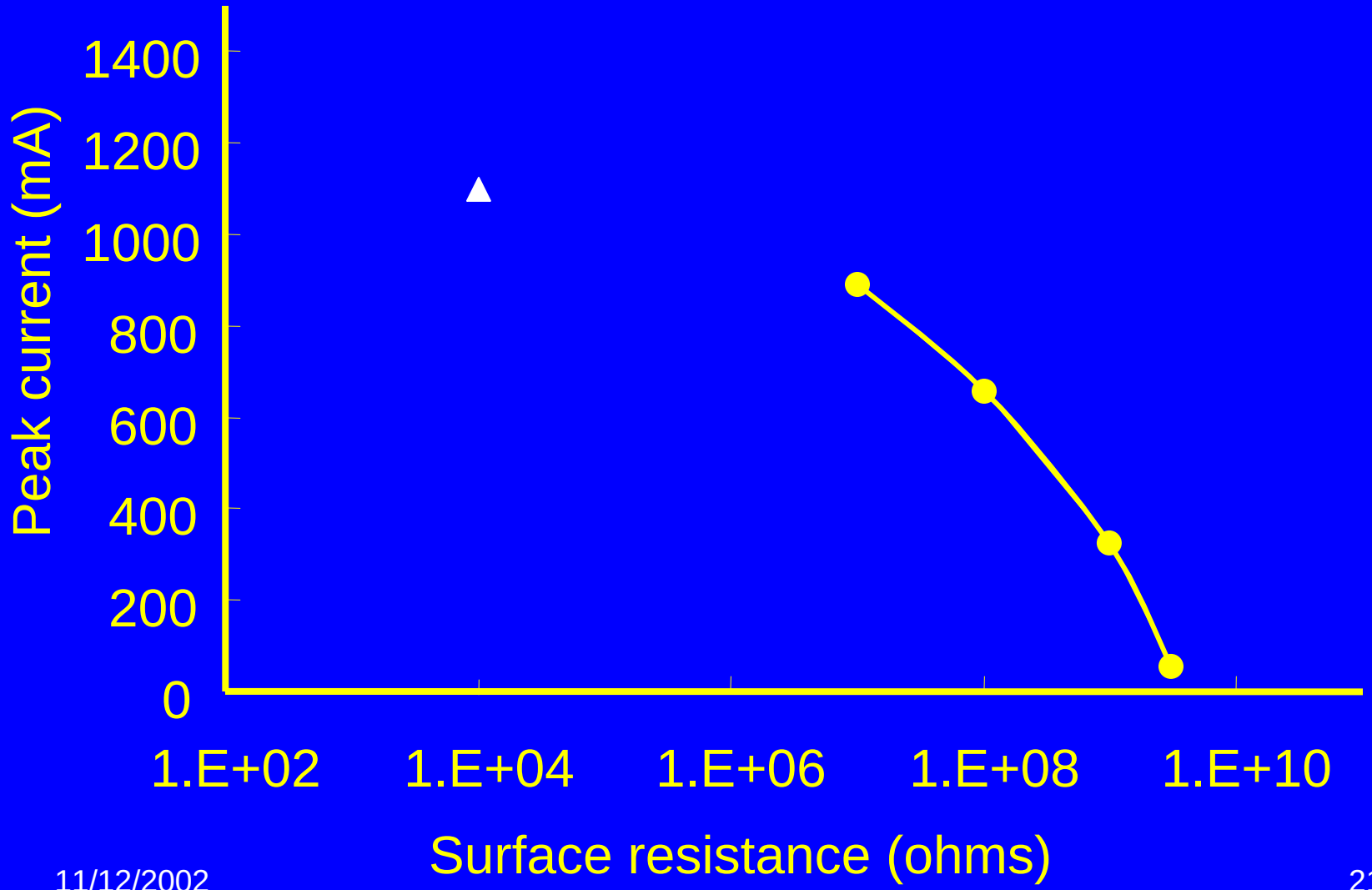


Peak current analysis

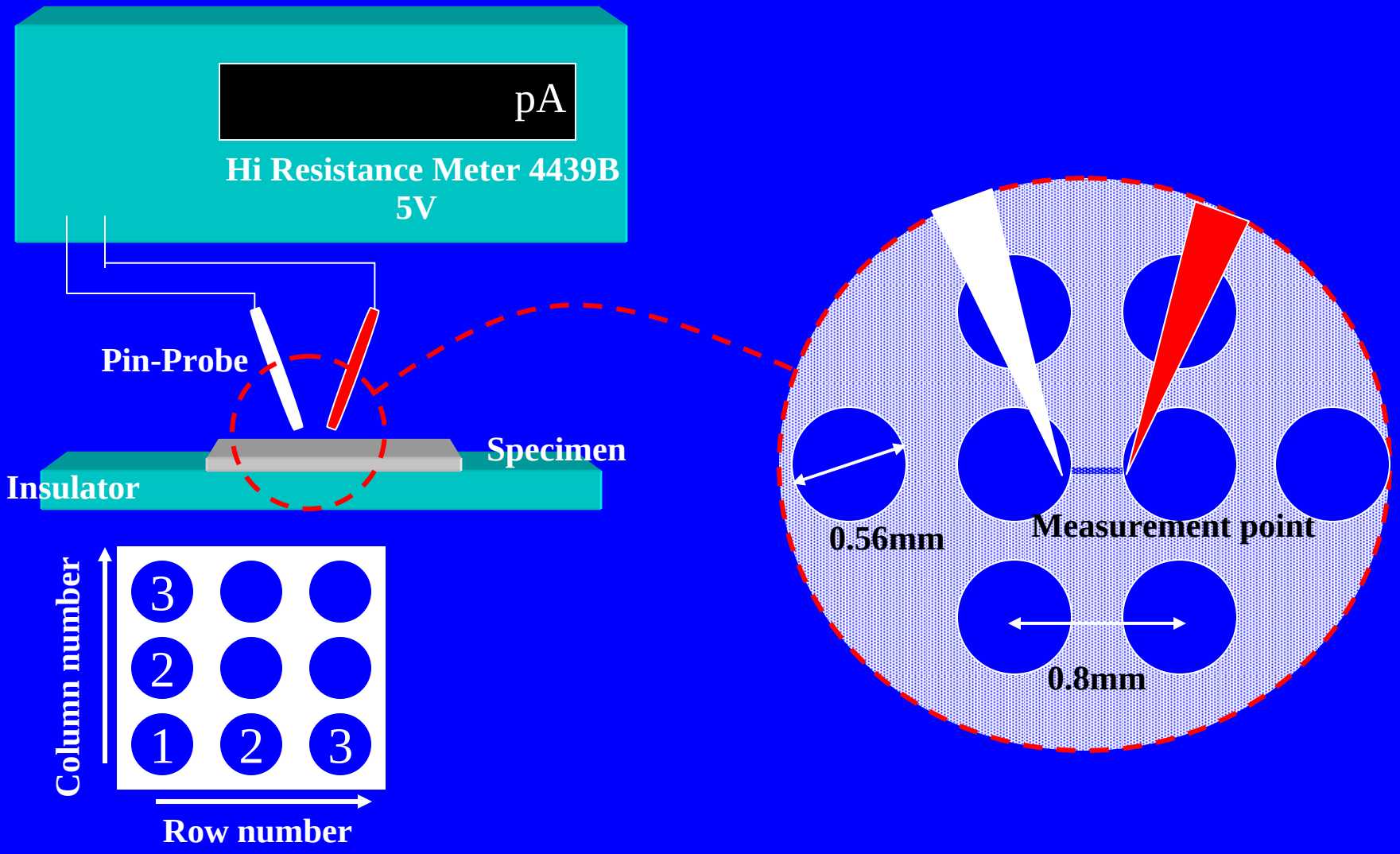


- Generated current on ESD provides a serious damage to devices.
- Magnitude of peak current on ESD is estimated by monitoring wave form during discharging.

Peak current analysis

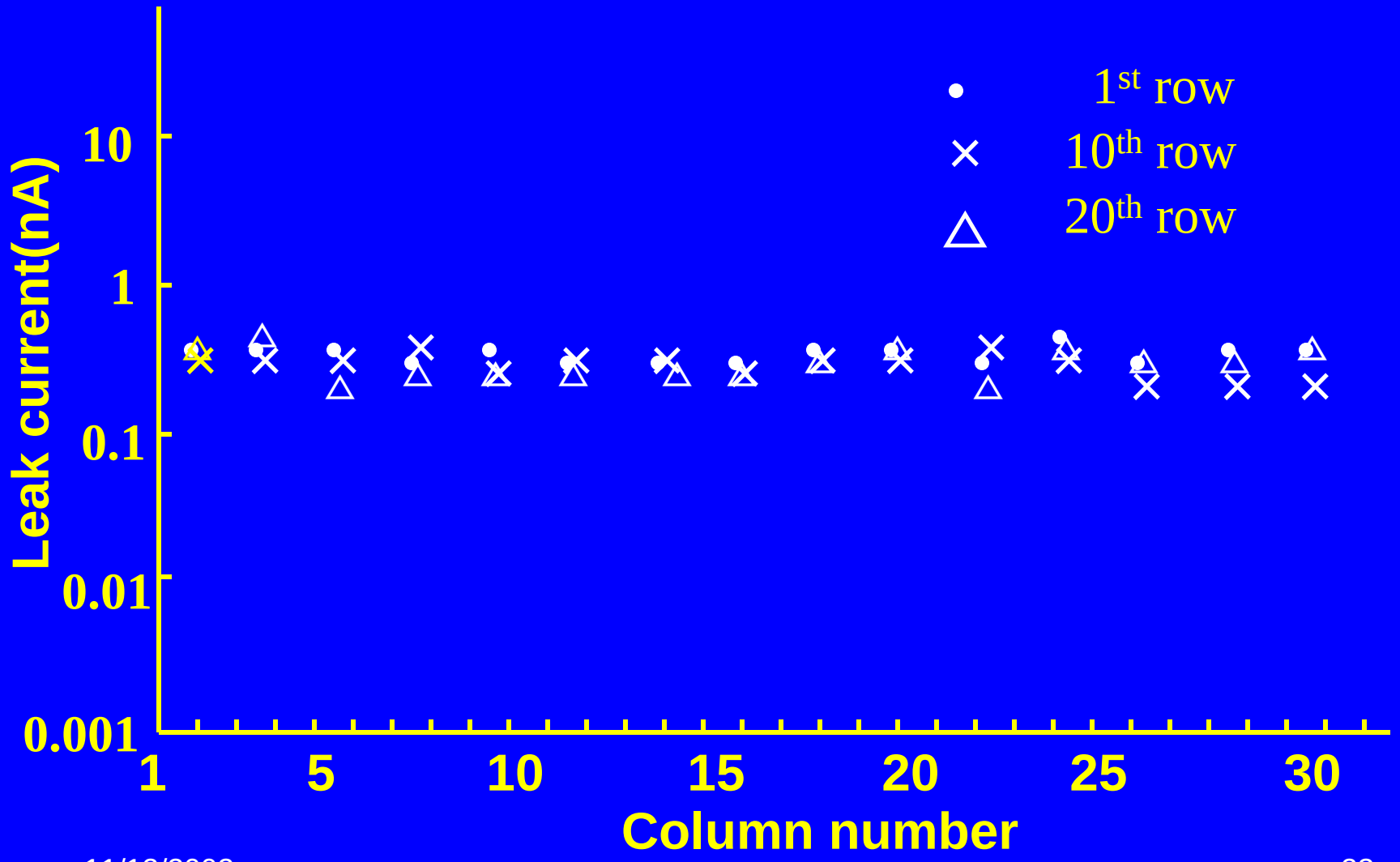


Leak current analysis



Schematic of Current analysis

Leak current analysis



Other properties

Properties	Units	EKH-SS07	EKH-SS09	EKH-SS11
Specific gravity	-	1.33	1.31	1.31
Tensile strength	Mpa	140	135	110
Rockwell hardness	M scale	125	125	125
Heat deflection temperature 1.82MPa	ºC	305	305	280
Coefficient of linear thermal expansion 30ºC-140ºC	-	1.5	1.5	1.5

Other properties

Properties	Units	EKH-SS07	EKH-SS09	EKH-SS11
Continuous service temperature	ºC	260	260	260
Dielectric strength	kV/mm	-	2	5
Dielectric constant 1MHz	-	7.9	6.6	5.3
Dielectric loss tangent 1MHz		0.22	0.21	0.17
Surface resistance	ohms	10^{6-7}	10^{7-9}	10^{9-11}

Conclusion

- The ESD control materials having the surface resistivity at specific levels within a range of 10^6 to 10^{11} ohms were obtained by using the technology.
- The surface resistance fluctuation was very small and the surface resistance change against applied voltage was small.
- The suitable surface resistance range of ESD protection for socket was estimated in the range of 10^8 to 10^{11} ohms from various ESD characterization.