PRODUCT AND MATERIAL MÉLANGE

This final session focuses on new products and materials in the test and burn-in market. The first presentation looks at high-temperature burn-in readiness, discussing a burn-in socket solution designed to address cost, design and performance challenges of high temperature burn-in. Next on the agenda is a description of new technologies developed to produce high reliability stamped parts and elastomer contacts for a finer pitch and high performance applications. The final presentation covers a new and innovative ESD control molding compound for encapsulation, developed to reduce the ESD issues in the test process.

High Temperature Burn-in (Up to 200º C): Are We Ready Yet?

Noriyuki Matsuoka, Kazumi Uratsuji —Yamaichi Electronics Co., Ltd.
Jec Sangalang—Yamaichi Electronics USA
Ryota Takeuchi—NGK Insulators, Ltd.

Development of High Performance Spring Probe Pin and Elastomer Contact by Stamping

Samuel Pak, A.J. Park—IWIN Co. Ltd.

This Paper

ESD Safe Materials for Test Socket and Encapsulation

Tatsuya Kawasaki—Krefine Co., Ltd.

ESD Safe Materials for Test socket and Encapsulation

Tatsuya Kawasaki
Krefine Co., Ltd.

2013 BiTS Workshop
March 3 - 6, 2013

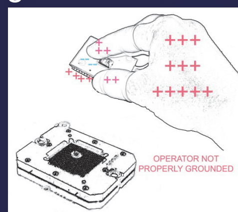
Agenda

- Research of the most suitable electrical properties of the material for backend process
  1. Leak current
  2. ESD event observation
  3. Tribo-charge
  4. Static decay
- ESD control material technology
- Applications for Test socket and Encapsulation
- Conclusion

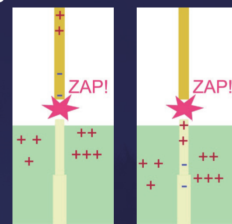
3/2013 ESD Safe Materials for Test Socket and Encapsulation 2

What are ESD events in backend process?

Charged device ⇒ Test socket



Charged socket ⇒ Device



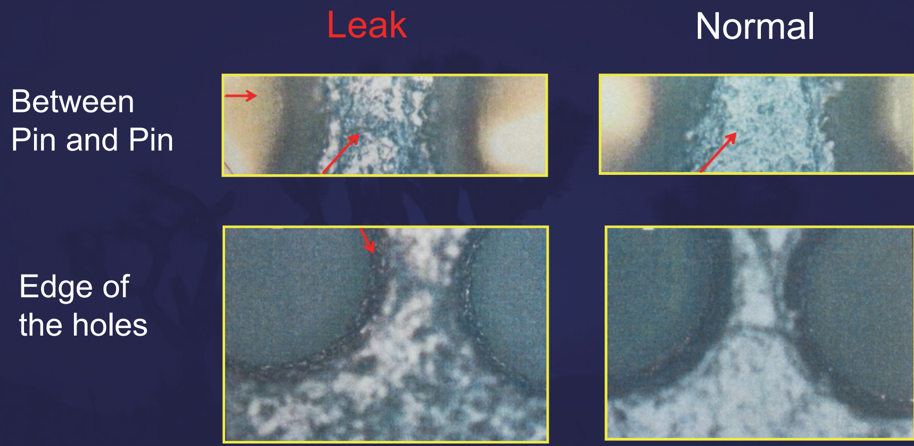
2 cases

ESD events happen between a test socket and an encapsulated device.

Recommended surface resistance from ESDA
(ANSI/ESD S541:2008)

- **Conductive : Rs (surface resistance) < $1\times 10^{4}\Omega$**
  - **Low charge accumulation**
  - **Rapid charge transfer (High Peak current)**
- **Electrostatic Dissipative : $1\times 10^{4}\Omega \leqq$ Rs $<$ $1\times 10^{11}\Omega$**
  - **Low charge accumulation**
  - **Moderately charge transfer**
- **Insulating : $1\times 10^{11}\Omega \leqq$ Rs**
  - **High charge accumulation**
  - **Very slow charge transfer**

Leakage issue happened at a test socket

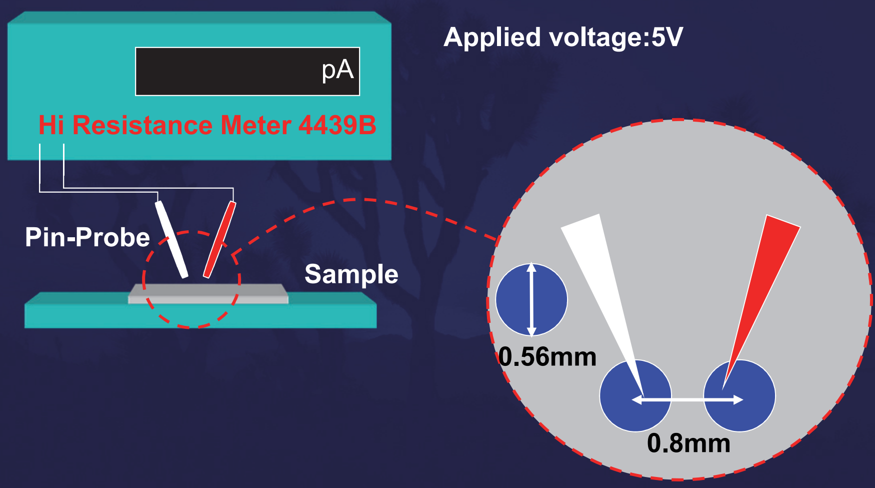


Leakage happened by using a dissipative material. Why?

Research of the most suitable electrical properties of the material for backend process

1. Leak current
2. ESD event observation
3. Tribo-charge
4. Static decay

1. Leak current evaluation



3/2013 ESD Safe Materials for Test Socket and Encapsulation 7

Result of leak current evaluation

Distance between two holes (0.8mm)

Rs(ohm)	Leak current (A) (applied 10V)
<E+04	> 10 μ
1.E+06 - 9.E+07	100n ~10 μ
1.E+08 - 9.E+09	10n ~ 100n
1.E+10 - 1.E+12	0 ~ 1n
>E+13	0 ~ 1n

Suitable range of Rs is over 1.E+10 ohm.

3/2013 ESD Safe Materials for Test Socket and Encapsulation 8

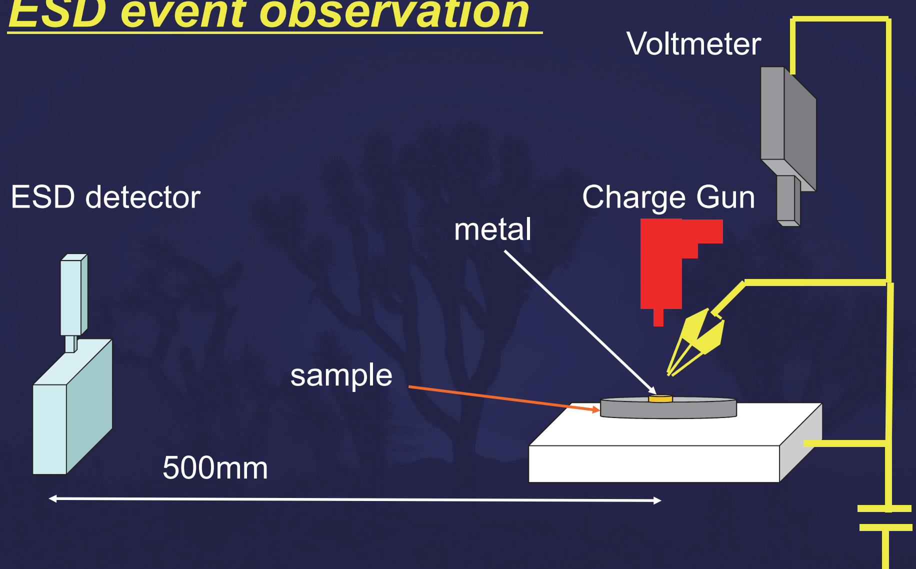
2. ESD event observation

ESD detector: EMI detect

- ESD can be detected by monitoring EMI
  (Electro Magnetic Interference)
- ESD is rapid current surge:
  Causes magnetic wave
- ESD is rapid drop of voltage:
  Causes electric field fluctuation.

3/2013 ESD Safe Materials for Test Socket and Encapsulation 9

ESD event observation



System : Ground / Not Ground

3/2013 ESD Safe Materials for Test Socket and Encapsulation 10

Result of ESD event observation

No Grounded system

Rs(ohm)	Surface Voltage after charged (V)	Surface Voltage after ground (V)	ESD detected level
<E+04	300 - 400	<20	Maximum level
1.E+06-9.E+07	400 - 500	<20	Maximum level
1.E+08-9.E+09	500 - 600	<50	Maximum level
1.E+10-1.E+12	600	200 - 300	Low level
>E+13	1000 - 1100	600 - 700	Maximum level

Rs under 9.E+09 show high charge transfer speeds.
Rs over 1.E+12 shows the biggest charge reduction.

3/2013 ESD Safe Materials for Test Socket and Encapsulation 11

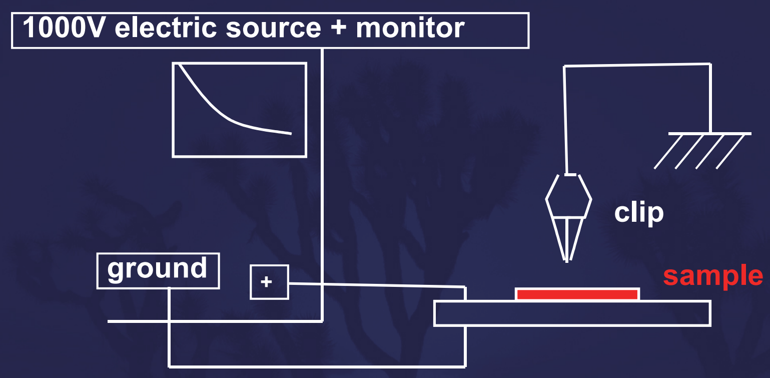
3. Tribo- charge

Rs(ohm)	Surface Voltage after rubbing by nitrile glove (V)	
<E+04	< 10	No charge accumulation
1.E+06-9.E+07	< 10	No charge accumulation
1.E+08-9E+09	< 10	No charge accumulation
1.E+10-1.E+12	100	Low accumulation
>E+13	650	High accumulation

The material with Rs over 1.E+12 has risks as a ESD material.

3/2013 ESD Safe Materials for Test Socket and Encapsulation 12

4. Static decay

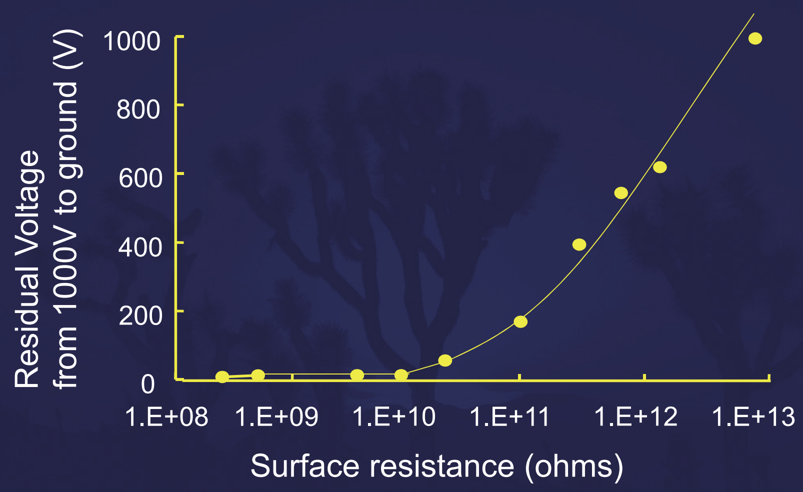


Charged Plate Monitor （Trek Model 158)

The static decay phenomenon from 1000V is measured by the above procedure.

3/2013 ESD Safe Materials for Test Socket and Encapsulation 13

Result of static decay



Material with Rs over 1.E+12 has much residual voltage.

3/2013 ESD Safe Materials for Test Socket and Encapsulation 14

Summary of ESD evaluations

Rs(ohm)	Leak current	ESD event	Tribo-charge	Static decay
<E+04	High	Max	No charge	No
1.E+06-9.E+07	High	Max	No charge	No
1.E+08-9.E+09	High	Max	No charge	No
1.E+10-1.E+12	Low	Low	Low	Low
>E+13	Low	Max	High	High

Rs between 1.E+10 and 1.E+12 is totally balanced for ESD control materials.

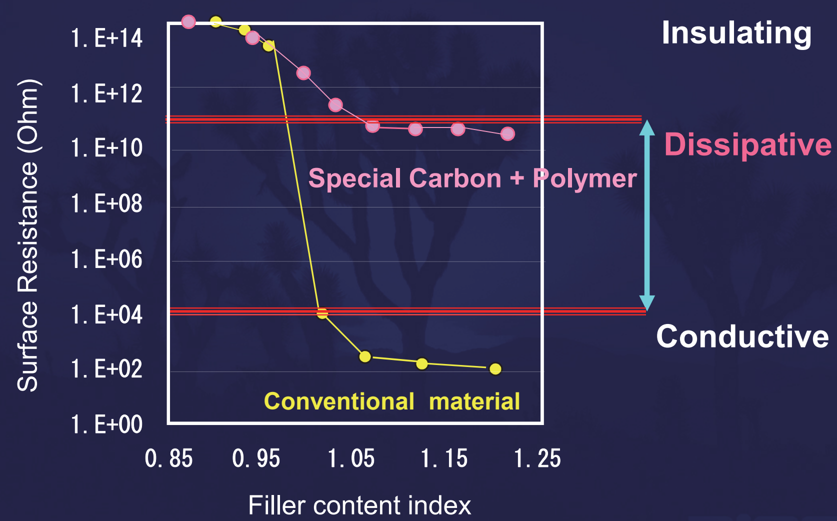
3/2013 ESD Safe Materials for Test Socket and Encapsulation 15

ESD Control Material Technology

3/2013 ESD Safe Materials for Test Socket and Encapsulation 16

ESD control material technology

Percolation model for surface resistance



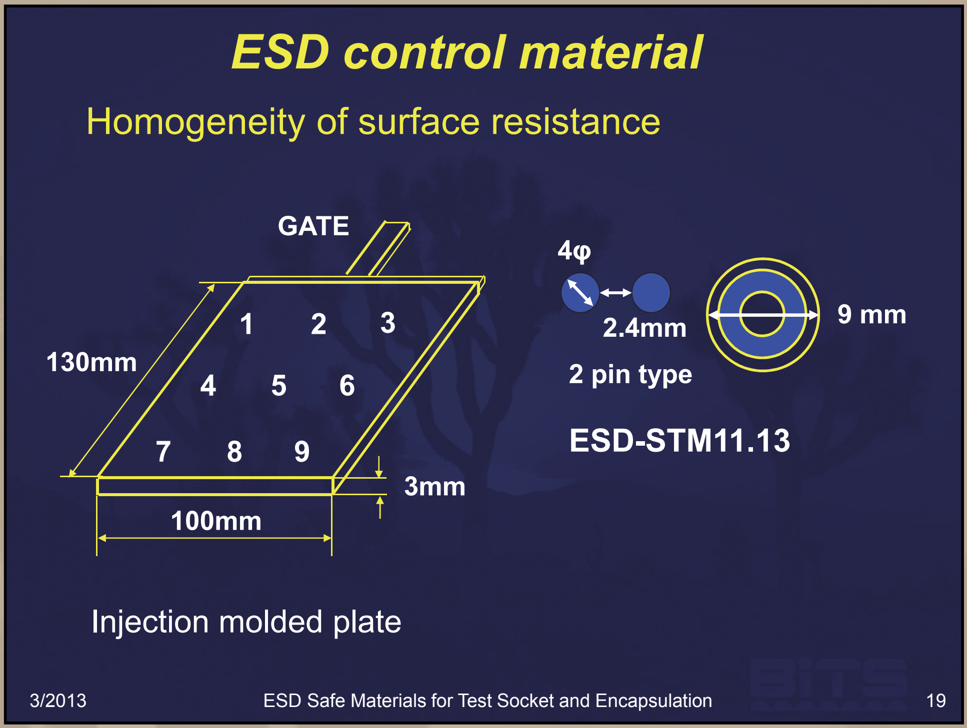
3/2013 ESD Safe Materials for Test Socket and Encapsulation 17

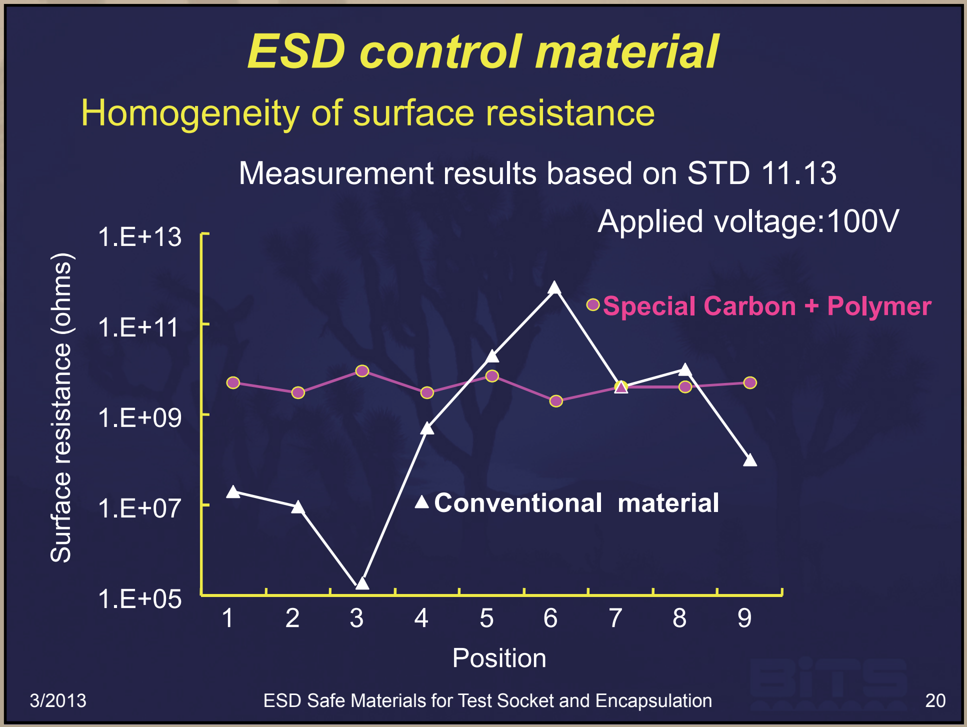
ESD control material technology

Special Carbon + Polymer

- Compounding special carbon material having electrostatic dissipative resistance and polymers.
- Optimize production process
  - Raw material blend
  - Extrusion (Pelletizing)
  - Injection molding

3/2013 ESD Safe Materials for Test Socket and Encapsulation 18

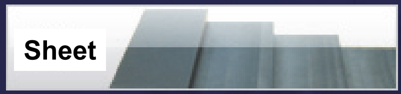

ESD control material
Homogeneity of surface resistance
GATE
130mm
1 2 3
4 5 6
7 8 9
3mm
100mm
4φ
2.4mm
2 pin type
9 mm
ESD-STM11.13
Injection molded plate
3/2013
ESD Safe Materials for Test Socket and Encapsulation
19

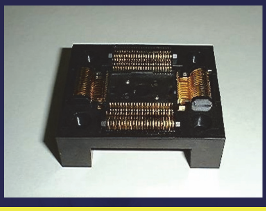

ESD control material
Homogeneity of surface resistance
Measurement results based on STD 11.13
Applied voltage:100V
Surface resistance (ohms)
1.E+13
1.E+11
1.E+09
1.E+07
1.E+05
Special Carbon + Polymer
Conventional material
1 2 3 4 5 6 7 8 9
Position
3/2013
ESD Safe Materials for Test Socket and Encapsulation
20

Applications for Test socket and Encapsulation

Application for Test socket

Ten years experience in the market





Properties	Units	EKH-SS11
Base Polymer		Polyetheretherketone (PEEK)
Specific gravity	-	1.31
Surface resistance	ohms	$10^{10\text{-}12}$
Dielectric constant 1MHz	-	5.3
Dielectric loss tangent		0.17
Dielectric strength	kV/mm	5

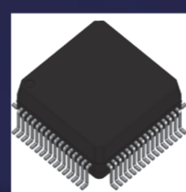
Application for Test socket

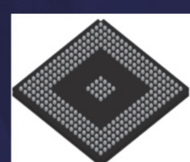
Properties	Units	EKH-SS11 (PEEK)
Flexural strength	MPa	170
Flexural modulus	MPa	6,000
Rockwell hardness	M scale	125
Coefficient of linear thermal expansion 30ºC-140ºC	/ ℃	1.5×10^{-5}
Water absorption (24H)	Wt%	0.2
Heat deflection temperature 1.82MPa	ºC	280

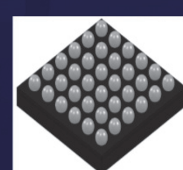
Application for encapsulation

ESD typically happen at three stages:

1. *Tribo-electric charge during the encapsulation process of the insulating molding compound.*
2. *Induction charge after the encapsulation.*
3. *Charge accumulation on the surface of the encapsulation.*







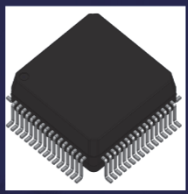
Application for encapsulation

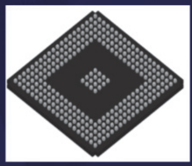
Conventional material : insulating

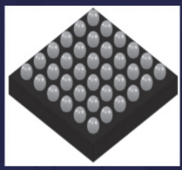
↓

New developed material

1. **Strictly controlled Rs (1.E+10 to 1.E+12)**
2. **Slow discharge**
3. **Low peak current**
4. **Tailor-made**







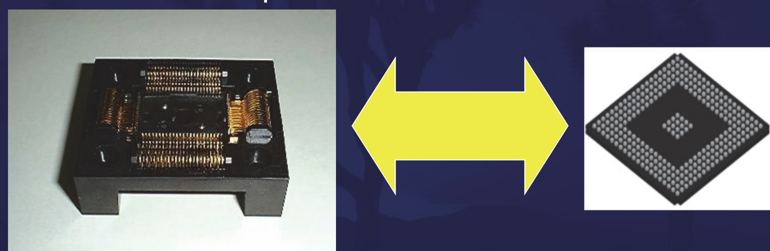
3/2013 ESD Safe Materials for Test Socket and Encapsulation 25

Conclusion

3/2013 ESD Safe Materials for Test Socket and Encapsulation 26

Conclusion

- The combination of test socket materials with the surface resistance of 1.E+10 ohm to 1.E+12 ohms and the encapsulation with the surface resistance of 1.E+10 ohm to 1.E+12 ohms is expected to be the best selection for ESD proactive countermeasure.



- From various ESD evaluation, the good balance between charge transfer and charge accumulation is kept in the above Rs range.