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## Challenges for Elastomer Interposer Application for System Level Test of PoP Package

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**TSE Corporation**



Mesa, Arizona • May 1-4, 2022



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- Package Trend
- Introduction of PoP
- Test Sockets for PoP Testing
- Comparison Between Spring Pin and Elastomer
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Challenges for Elastomer Interposer Application for System Level Test of PoP Package

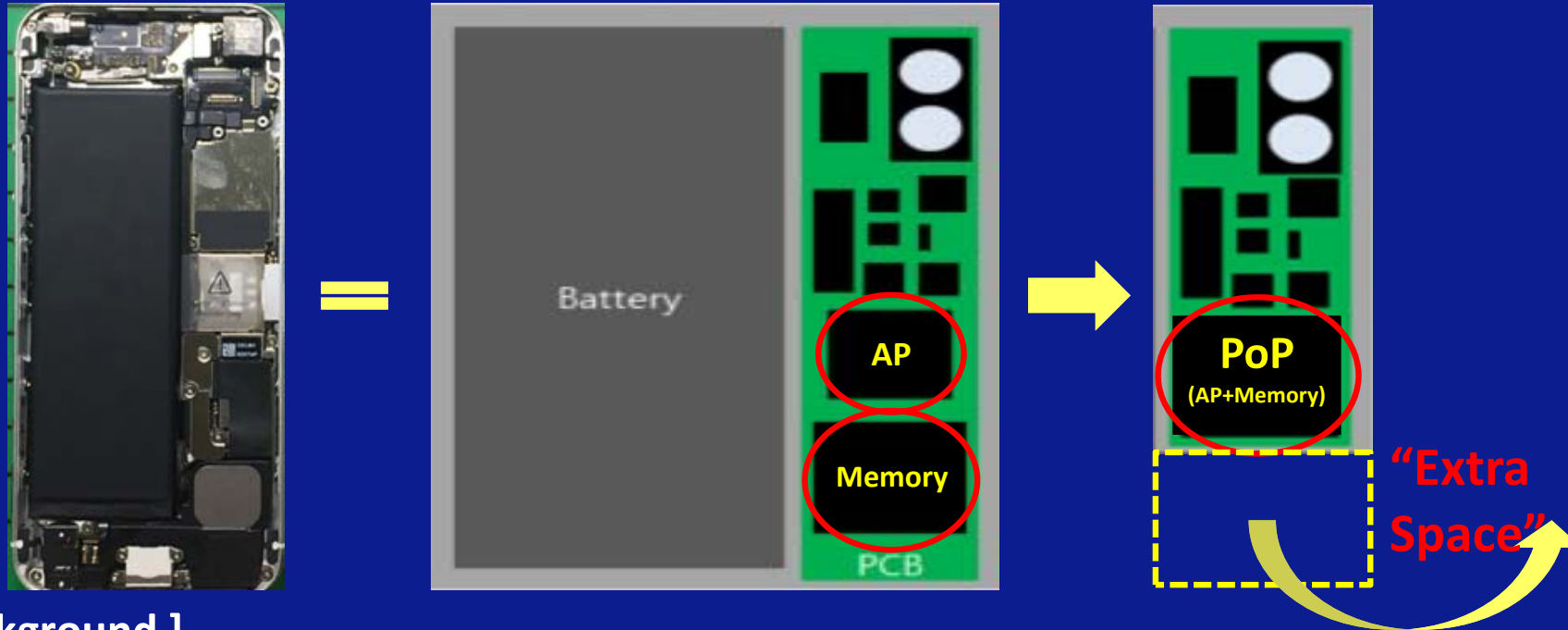
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[ Package Trend ]

**“Small Form Factor such as Package on Package”**



[ Background ]

**“Speed Demand, Low Power, Higher Integration”**



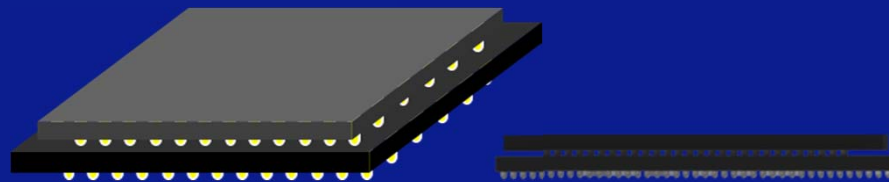
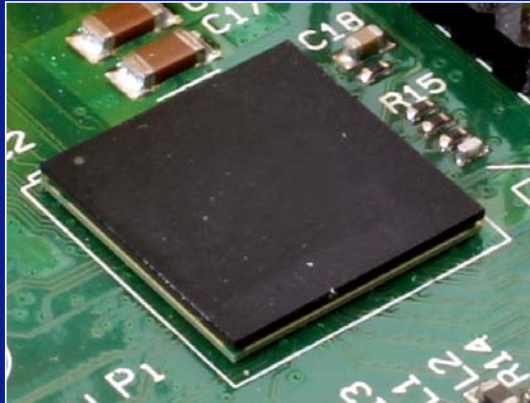
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## POP Definition & Concept

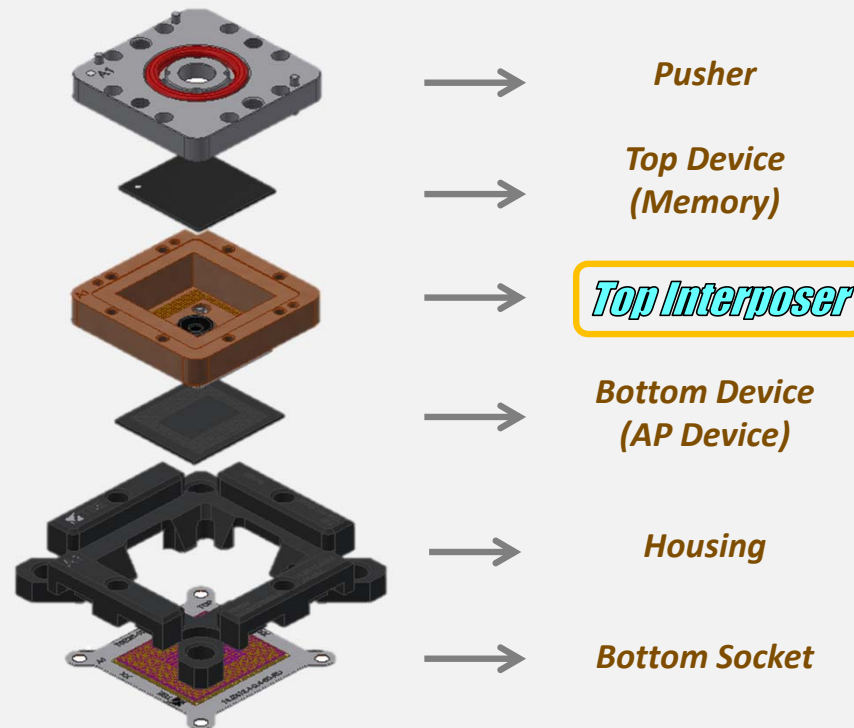
***POP***



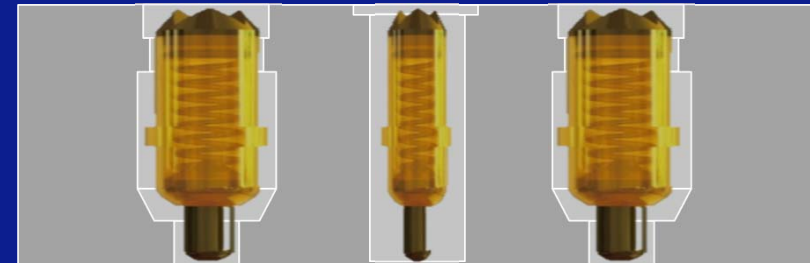
- ✓ Package on Package
- ✓ Packages Stacked Together
- ✓ Signal & Electrical Characteristics
- ✓ Space Efficiency

## Spring Pin Sockets for PoP Testing

### Structure



### "Spring Pin Type"



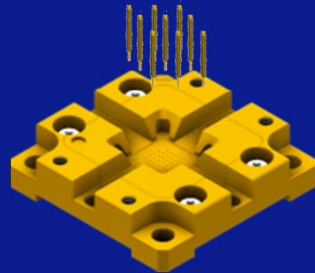
- ✓ Bi-directional Force Applied
- ✓ Competitive in Durability & Lifespan

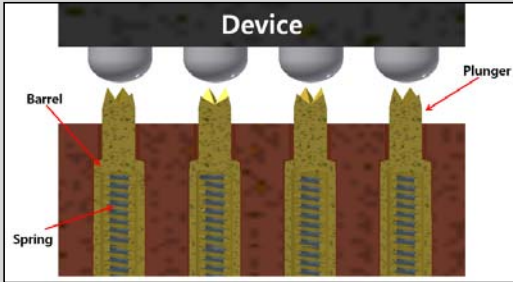
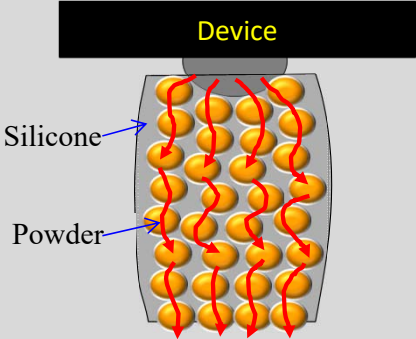


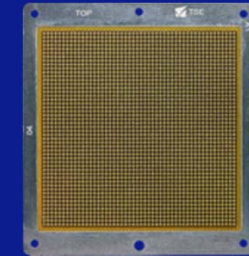
### Challenges

- ✓ Higher Signal Speed
- ✓ Lower Pitch
- ✓ Higher Integration

## Structural Difference



	Spring Pin	Elastomer
Parts	Spring, Barrel, Plunger, Housing	Silicone Rubber, Powder, Frame
Contact Point	Plunger	Powder
Motion Section	Spring	Silicone
Structure		



## Spring Pin vs. Elastomer Comparison Overview

1. Electrical Length
2. Electrical Performance
3. Tin Migration
4. Contact Area Coverage



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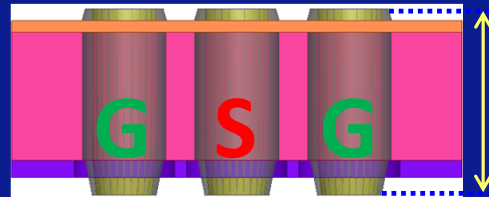
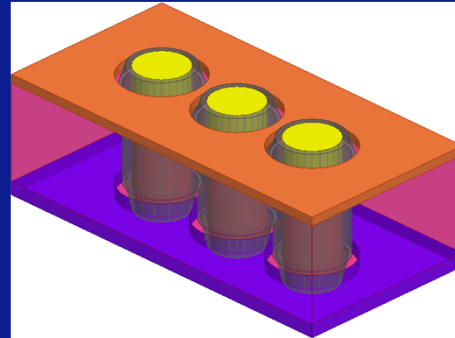
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## Comparison of Electrical Length

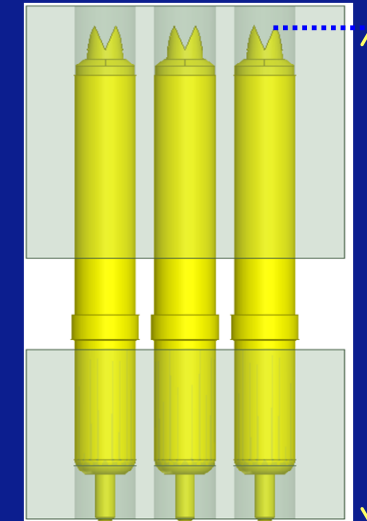
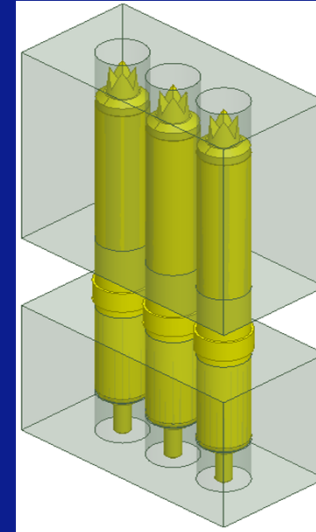
[ Elastomer Socket ]



Socket Height

0.80mm

[ Spring Pin Socket ]



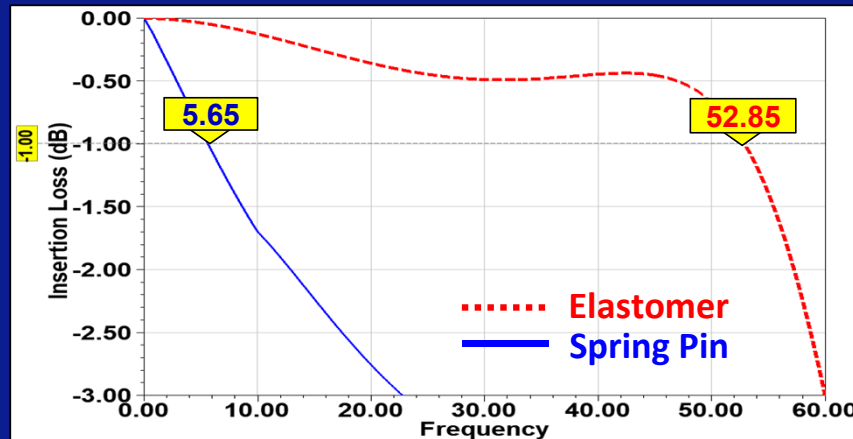
Socket height

3.40mm

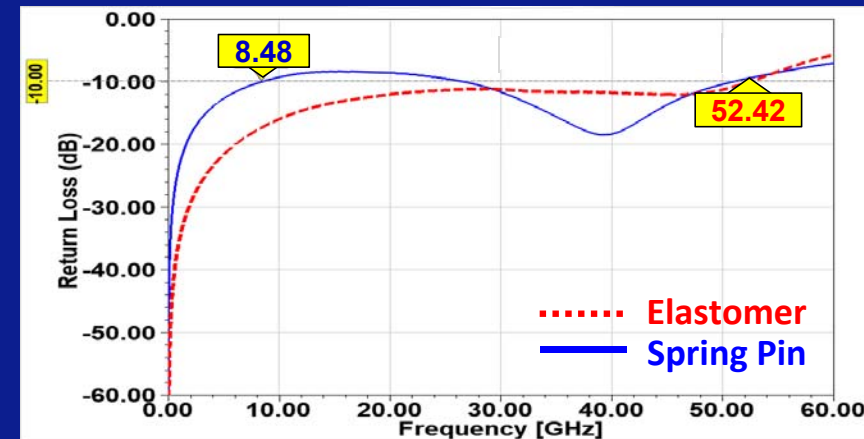
$\times 4.25$

*Height Difference*

## Comparison of Electrical Performance



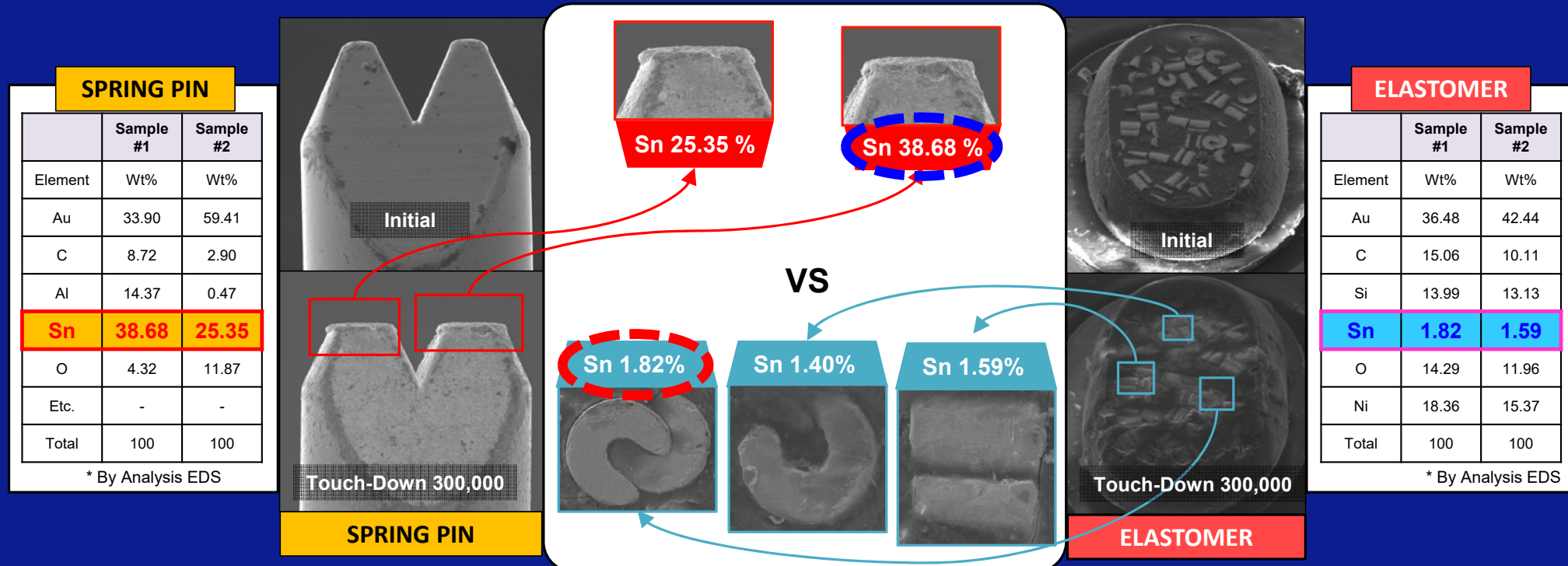
[ Insertion Loss ]



[ Return Loss ]

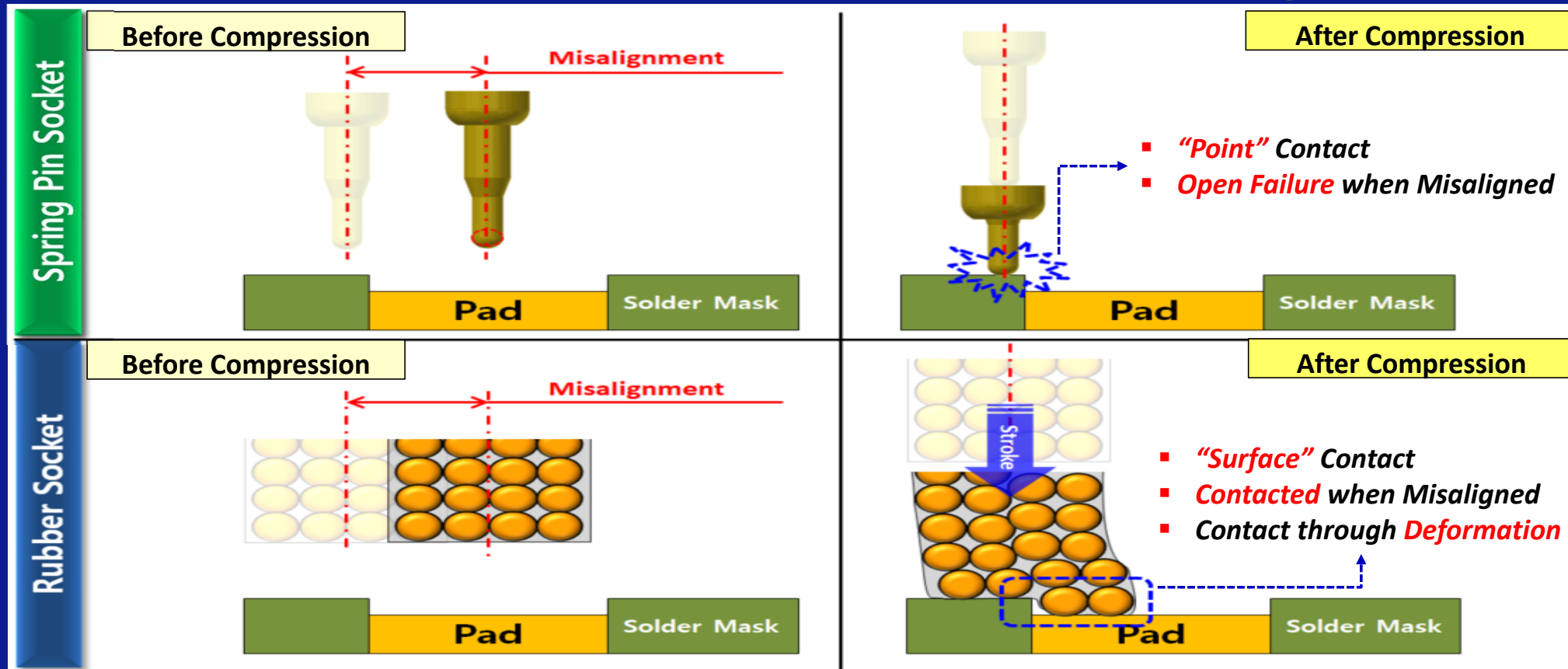
✓ **Better Electrical Performance on Elastomer**

## Comparison of Tin Migration



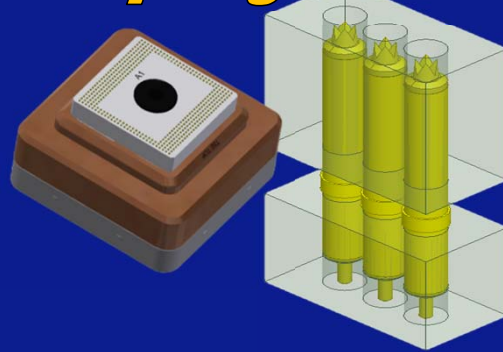
✓ **Less Tin Migration Found on Elastomer than Spring Pin**

## Comparison of Contact Area Coverage

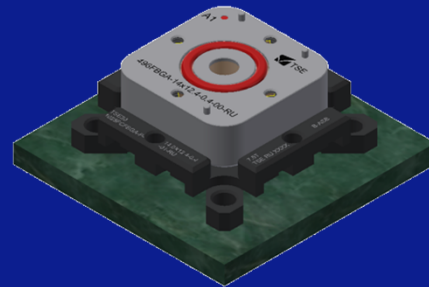
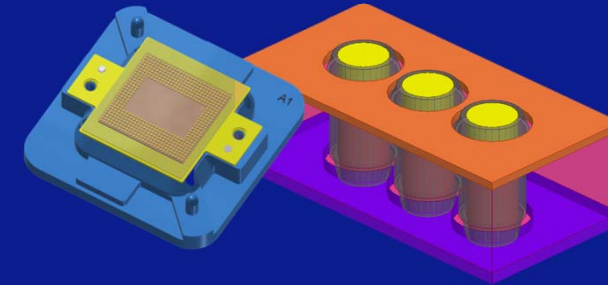


## Result of Transition

*Spring Pin*



*Elastomer*



Signal Characteristics



Ball Damage

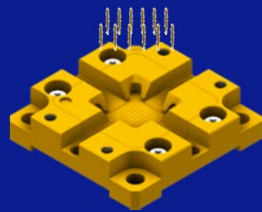


Contact Performance

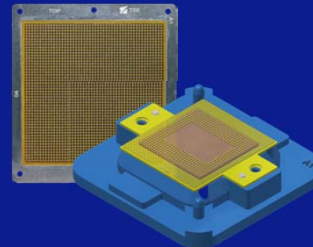


## Comparison Summary

	Speed	Alignment	Ball Damage	Maintenance	Pitch
<b>SPRING PIN</b>	<ul style="list-style-type: none"> <li>✓ High Socket Height</li> <li>✓ Signal Characteristics ↓</li> </ul>	<ul style="list-style-type: none"> <li>✓ Edge Contact</li> <li>✓ No Deformation</li> </ul>	<ul style="list-style-type: none"> <li>✓ Crown Contact</li> <li>✓ High Ball Damage</li> </ul>	<ul style="list-style-type: none"> <li>✓ Requires Periodical Cleaning</li> </ul>	<ul style="list-style-type: none"> <li>✓ Reduction Limit</li> </ul>
<b>ELASTOMER</b>	<ul style="list-style-type: none"> <li>✓ Low Socket Height</li> <li>✓ Signal Characteristics ↑</li> </ul>	<ul style="list-style-type: none"> <li>✓ Surface Contact</li> <li>✓ Deformation</li> </ul>	<ul style="list-style-type: none"> <li>✓ Powder Contact</li> <li>✓ Less Ball Damage</li> </ul>	<ul style="list-style-type: none"> <li>✓ Cleaning Unnecessary</li> </ul>	<ul style="list-style-type: none"> <li>✓ Fine Pitch</li> </ul>



*Spring Pin*



*Elastomer*



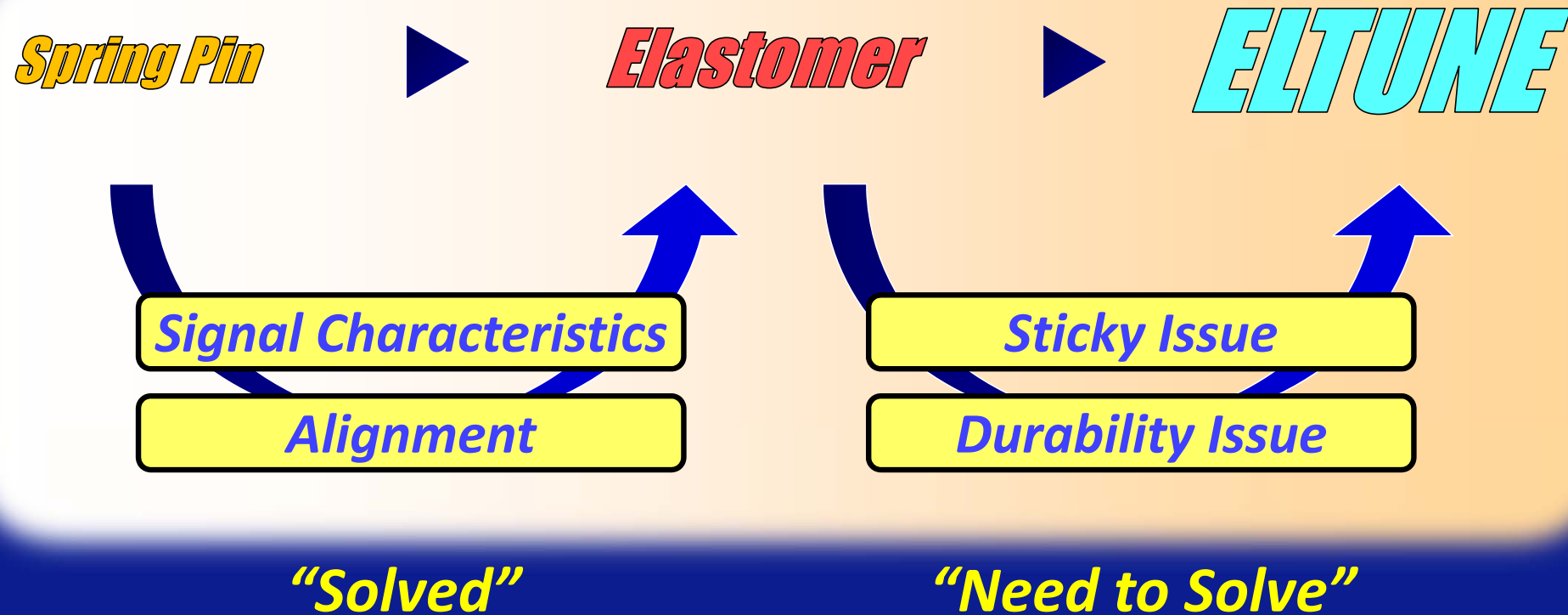
*Next Generation  
Socket*

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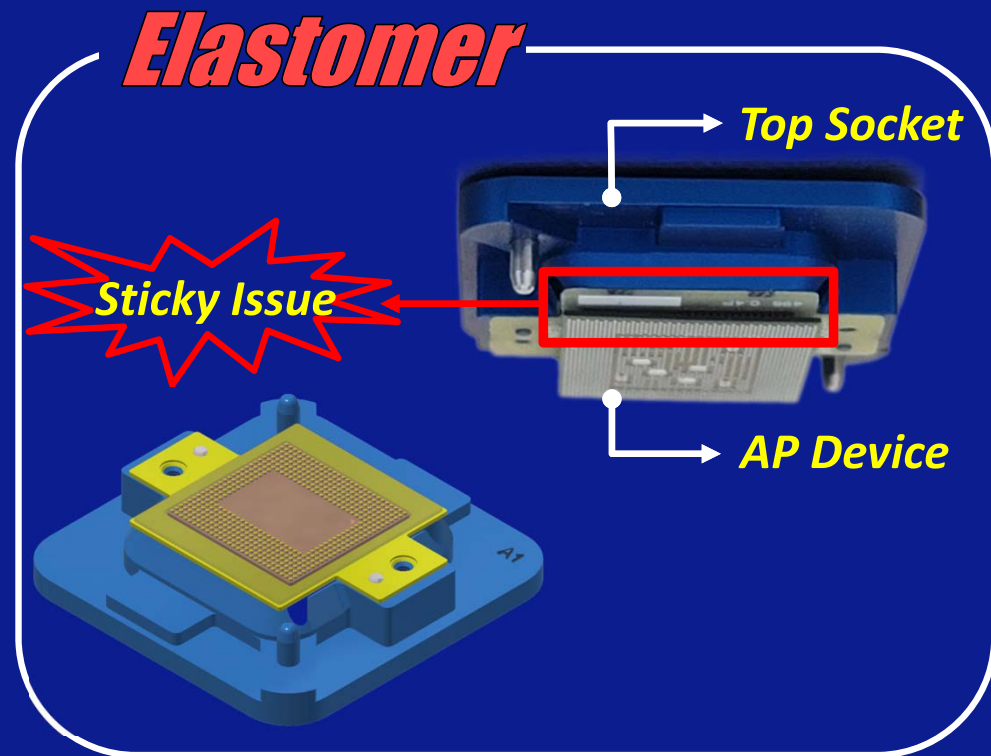
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## Challenges of Transition



## Sticky Issue – Overview



### Condition

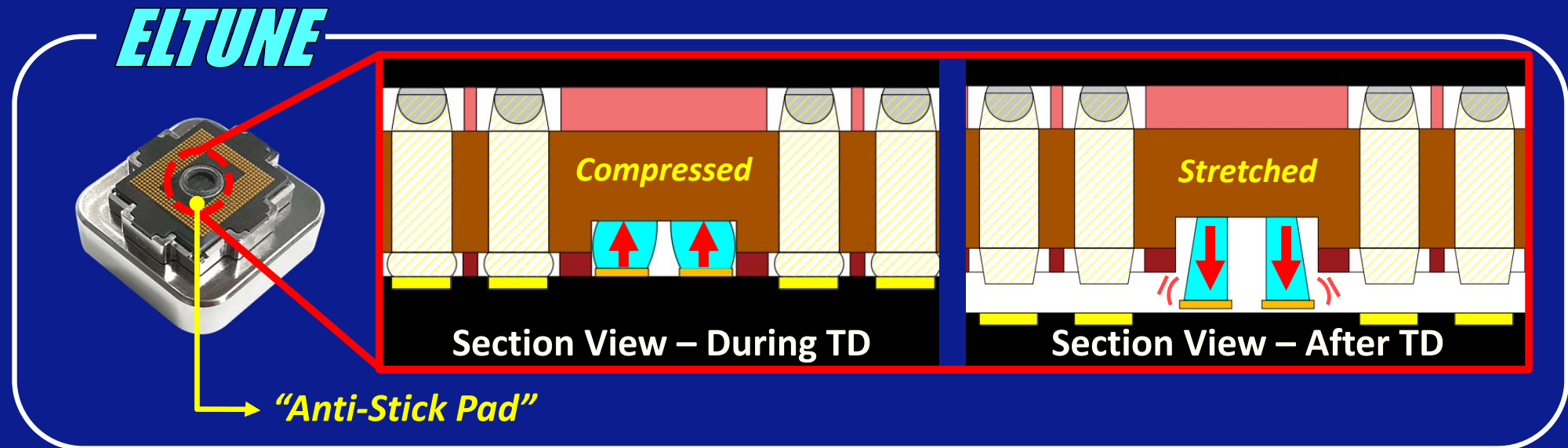
- ✓ Heat & Pressure Applied During Test
- ✓ Emergence of Silicone Oil



### Consequence

- ✓ Pick-up Error
- ✓ Test Interruption & Delay
- ✓ Leave Residue on Device

## Sticky Issue – Prevention



### Method

- ✓ *Applied Anti-Stick Pad*

### Process

- ✓ *Push Device Using Elasticity*

### Outcome

- ✓ *Device Position Maintained*

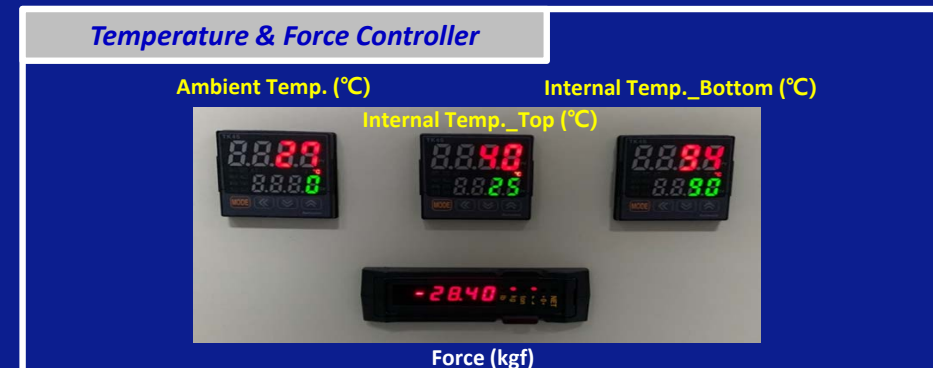
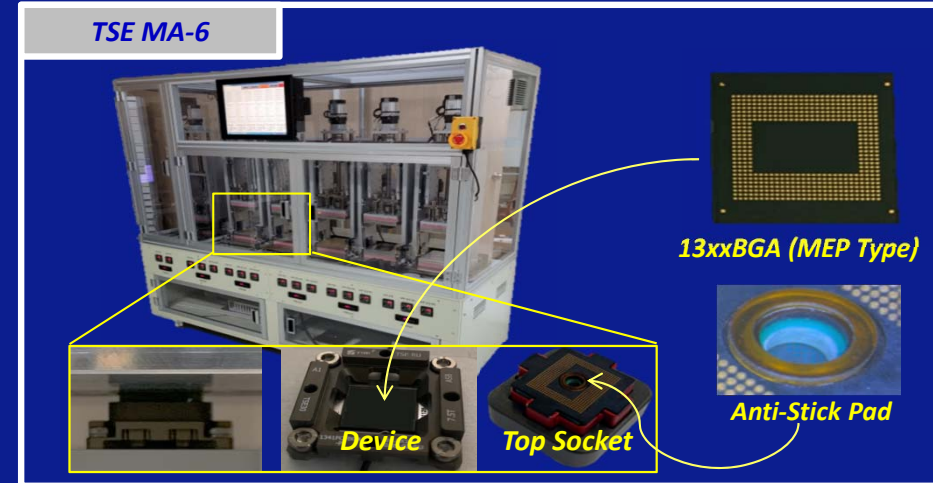
## Sticky Issue – Evaluation Condition

### ❖ *Evaluation Set-up*

- Tester : TSE MA-6 (Repetitive Contact Machine)
- Temp. : +90 °C
- Pushing Force : 28kgf
- Method
  - Apply Touch Down by Using Top Socket
  - The Contact Time Starts at 30 min.
  - Increases by 10 min. Until Device Sticks

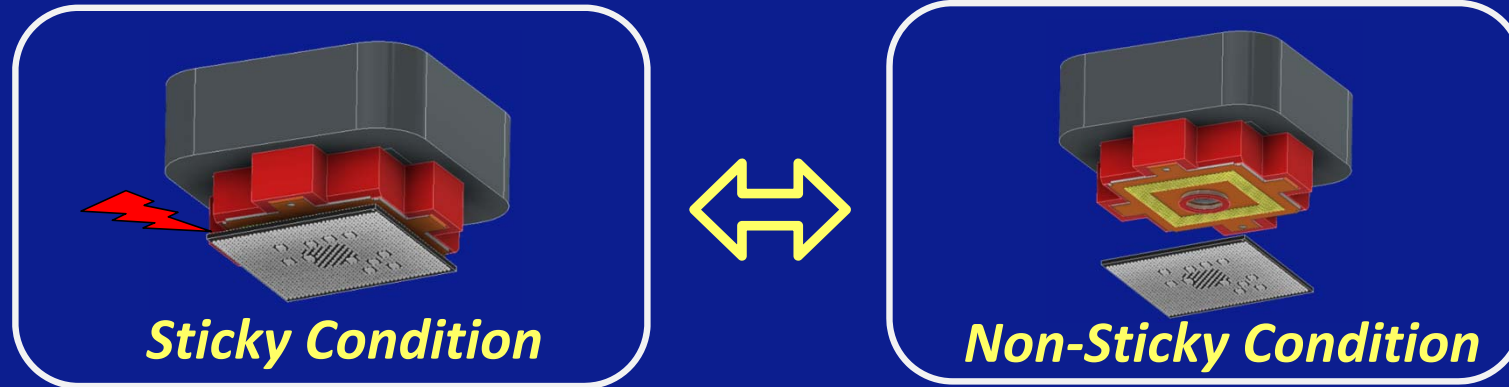
Contact Time (min.)	30	40	50	60	...	...
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- Check Device Stick Through Laser Sensor





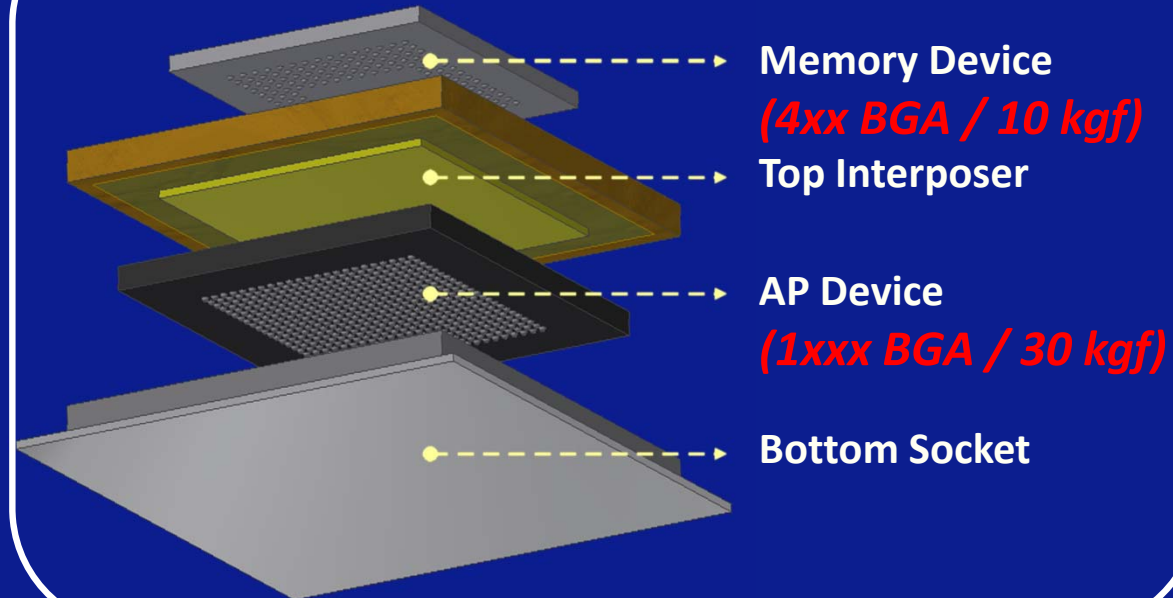
## Sticky Issue – Anti Stick Evaluation



Test Time	670 min.	680 min.	690 min.	700 min.
Condition	No Sticky Issue	No Sticky Issue	No Sticky Issue	No Sticky Issue
View	 	 	 	 

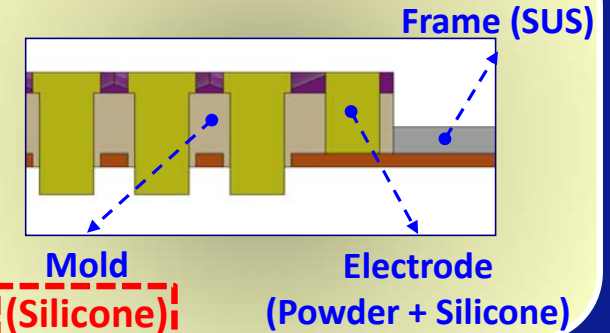
## Durability Issue

### 3D Example

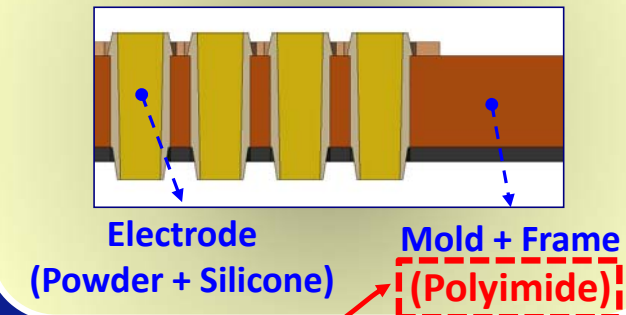


❖ **Main Difference : Body Material**

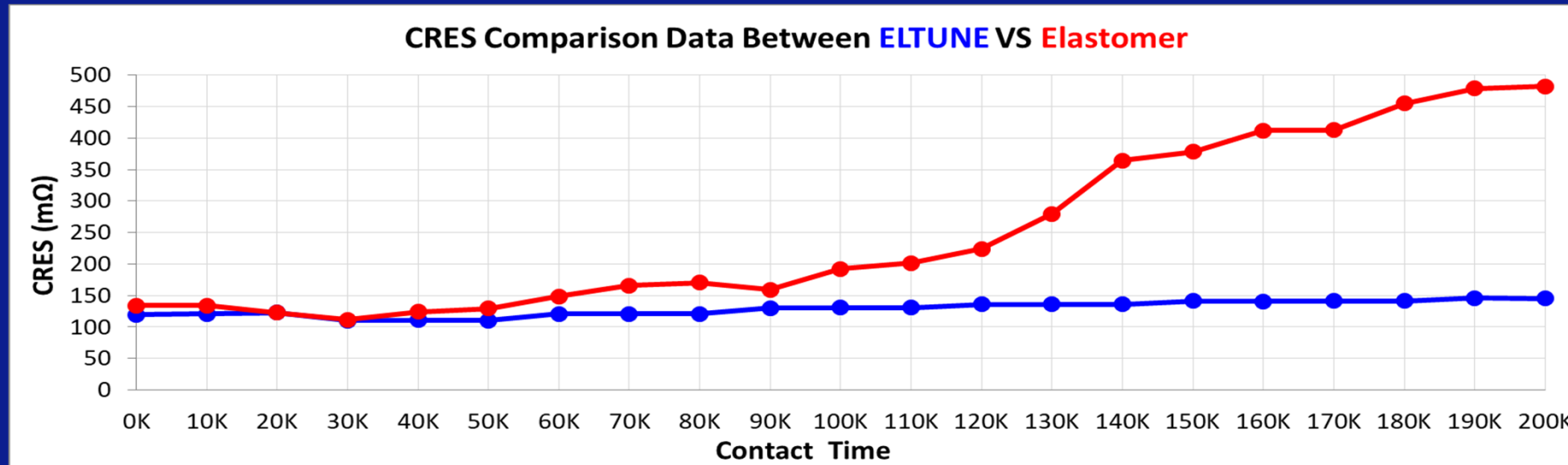
### Elastomer



### ELTUNE



## Durability Issue – CRES Comparison



**Elastomer**



**Unstable & High Cres Value @ Touchdown Increase**

**ELTUNE**



**Stabilized & Consistent Cres Value @ Touchdown Increase**

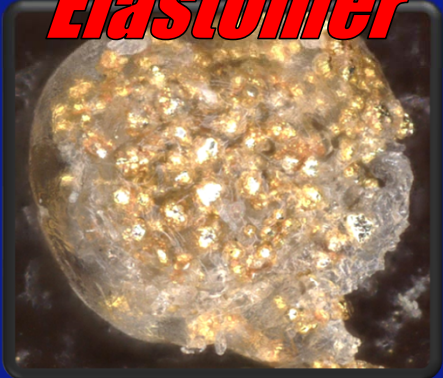
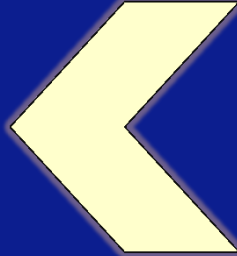



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## Durability Issue – Condition Comparison

<p><b><i>Elastomer</i></b></p> 		<p><b><i>ELTUNE</i></b></p> 
<p>❖ 200K</p> <p>❖ <b>481.98 mΩ</b></p> <p>❖ <b>Worn Out</b></p>	<p>Contact Time</p> <p>CRES Result</p> <p>Bump Condition</p>	<p>❖ 200K</p> <p>❖ <b>145.25 mΩ</b></p> <p>❖ <b>Consistent</b></p>

***∴ Damage & Depression Shown***

***∴ No Damage & Depression***


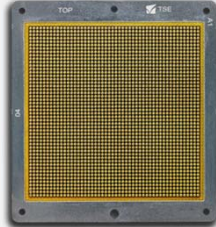
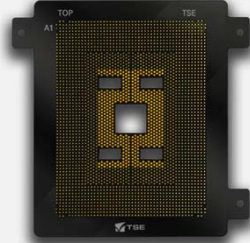


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## Final Comparison

Segment	SPRING PIN	ELASTOMER	ELTUNE
Image			
Pros	<ul style="list-style-type: none"> <li>✓ Lifespan</li> <li>✓ Compatibility</li> <li>✓ Force Endurance</li> </ul>	<ul style="list-style-type: none"> <li>✓ Improved Signal Characteristics</li> <li>✓ Contact Performance</li> <li>✓ Ball Condition</li> <li>✓ Less Cleaning</li> </ul>	<ul style="list-style-type: none"> <li>✓ Elastomer Advantages</li> <li>✓ Issue Settlement</li> </ul>
Cons	<ul style="list-style-type: none"> <li>✓ Alignment</li> <li>✓ Low SI Performance</li> <li>✓ Periodic Cleaning</li> <li>✓ Ball Damage</li> </ul>	<ul style="list-style-type: none"> <li>✓ Sticky Issue</li> <li>✓ Durability</li> </ul>	?



## Summary

- Higher Integration & Downsized Packages
- Emerge of Stacked Type Packaging to Meet Various Needs
- Spring Pin Sockets Mainly Used for PoP Testing
- Demands Higher Test Requirements
- TSE Proposes Elastomer Solution to Show Improvements
- Challenges for Transition and TSE Proposal
- Final Comparison Data



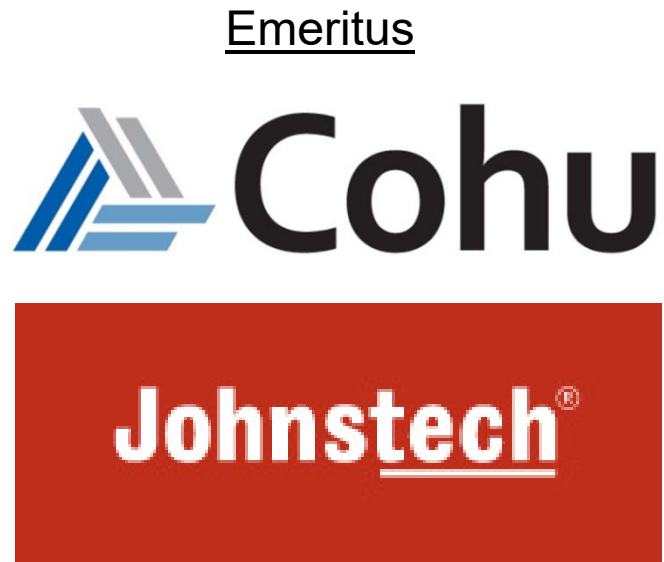
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