

A Wafer Level CSP Technology, Wafer Process Packaging-WPP

Toshio Miyamoto

Hitachi, Ltd

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Title

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Wafer Process Packaging-WPP

E-mail; miyamoto-toshio@sic.hitachi.co.jp

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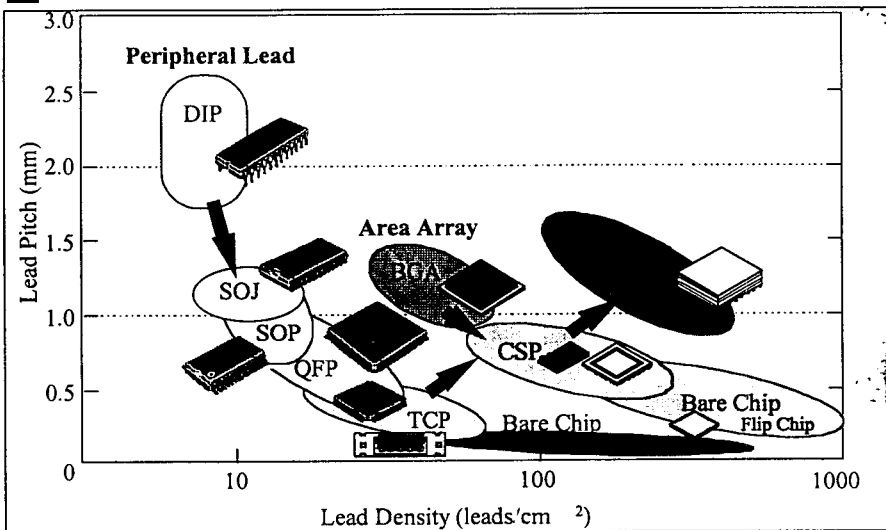
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WPP phase 1
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Sheet contact socket for WPP
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Note: Wafer Process Package ;WPP

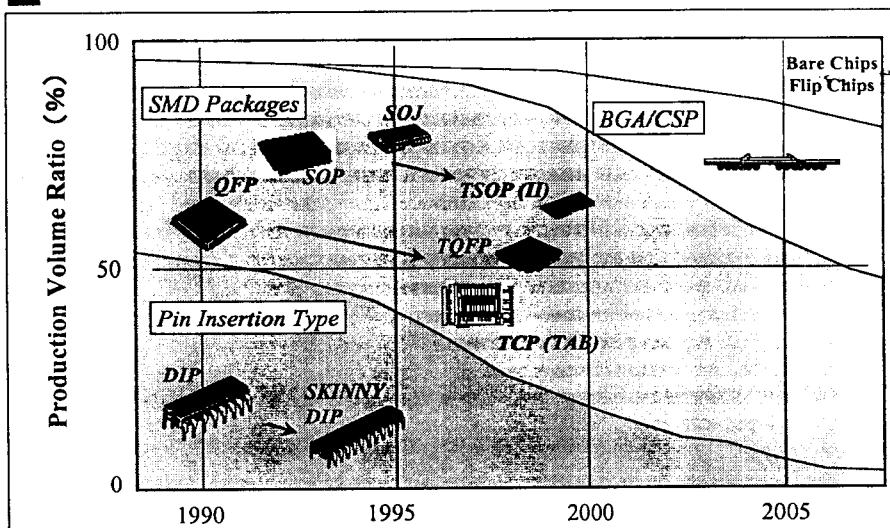
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Market Trend



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Production Ratio Per Package Type



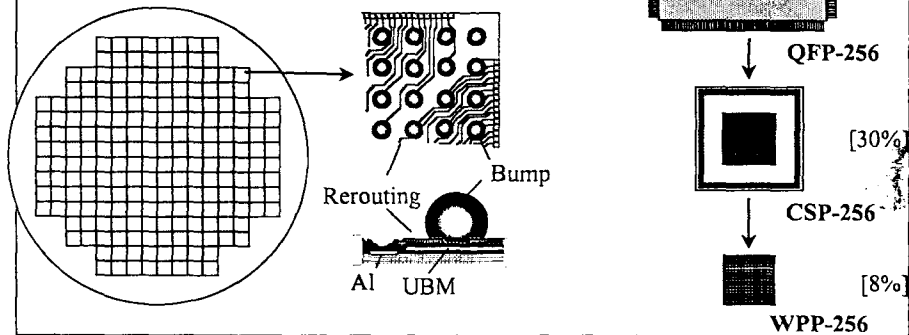
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Area Array Bumps by Rerouting

Wafer Process (Rerouting, Area Bump)

High Pin Count in Ultra Small Package ; 8%
vs. QFP/256pin

Wafer Processed CSP, High Productivity, QTAT

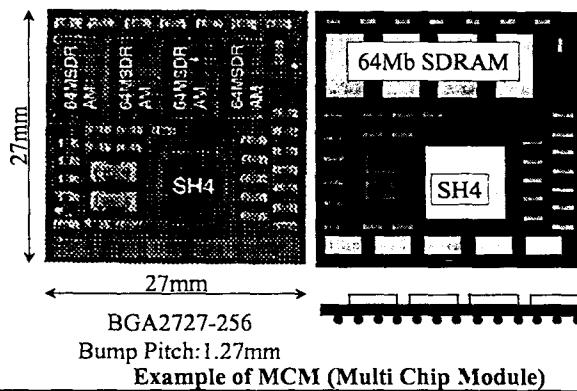


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Assembly Solution by MCM/MCP

Merit

- ◆ Inter-connections between high speed & high pin count chips
- ◆ Cost reduction & Performance improvement of user substrate



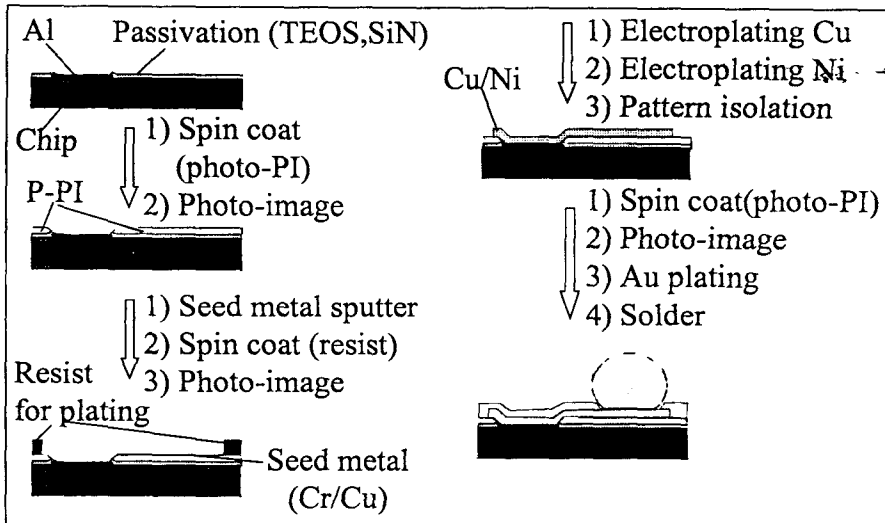
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Structure & Characteristics of WPPs

| Ver. | <u>Phase 1</u> | <u>Phase 2</u> |
|-----------------|----------------|--|
| Structure | | |
| Characteristics | UF required | Built in stress reduction mechanism Repairable: UF not required |

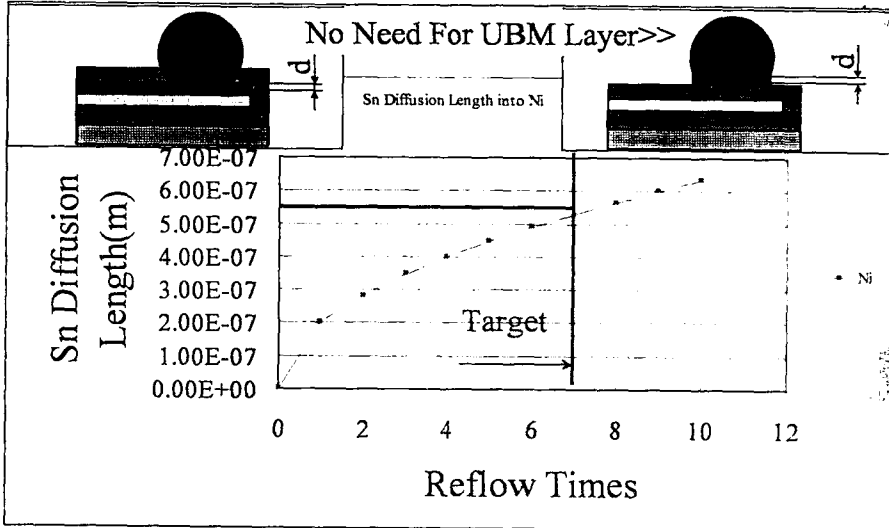
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Fabrication Schematic Flow of WPP Phase 1



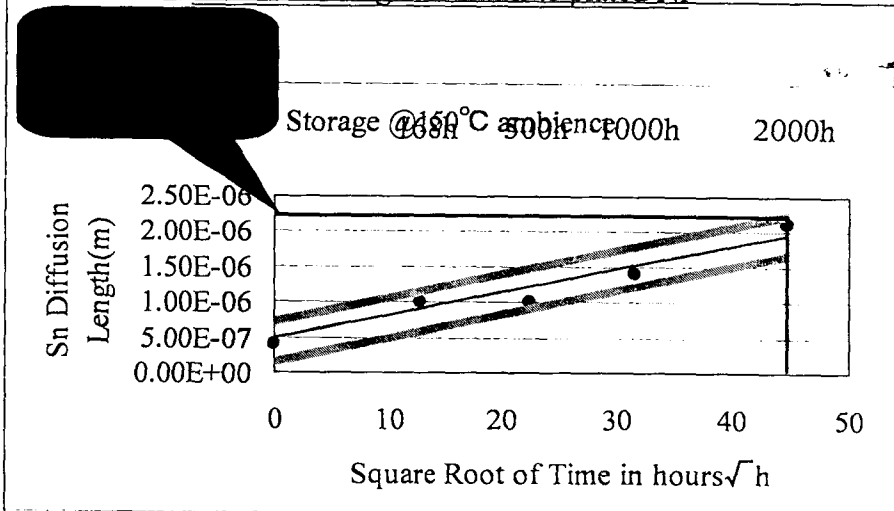
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Diffusion Length vs. # Of Reflow Process



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Diffusion Length under High Temperature Diffusion Length of Tin into plated Ni



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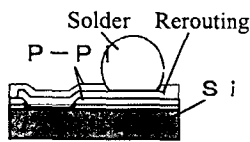
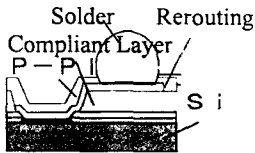
Reliability of WPP Phase1

| Test Type & Condition | @ | Fail/N |
|---|-------|--------|
| 30 degC/60%Rh/192h+IR240degC/10s/x5 | - | 0/90 |
| Temperature Cycle:-55degC/125 degC | 2000c | 0/195 |
| High Temperature Bias:150degC 3.6V bias | 1000h | 0/5 |
| Biased Humidity:85degC/85%Rh 3.6V bias | 1000h | 0/5 |
| Pressure Cooker Test:2atm 121degC | 300h | 0/40 |

Samples:Assembled onto FR-4 substrate with Underfill

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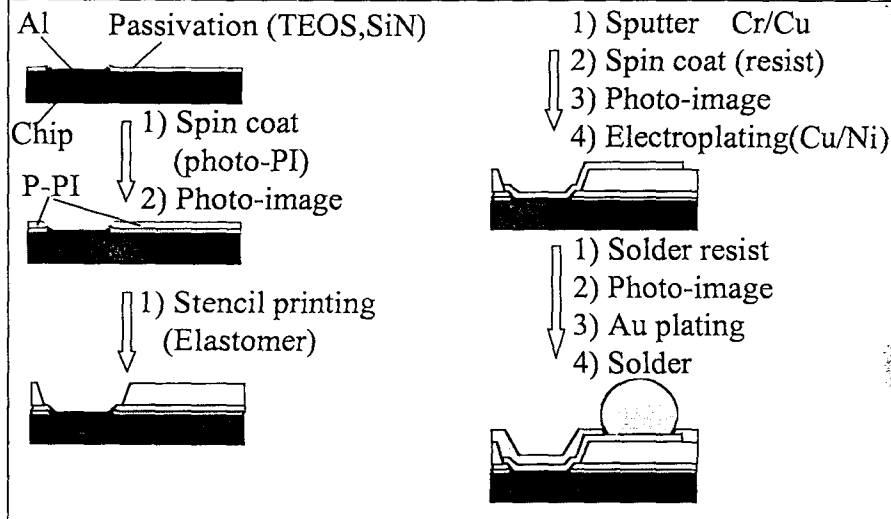
Structure & Characteristics of WPPs

| Ver. | <u>Phase 1</u> | <u>Phase 2</u> |
|-----------------|---|--|
| Structure |  |  |
| Characteristics | UF Required | Built in stress reduction mechanism Repairable:UF not required |

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Fabrication Schematic Flow for WPP Phase2

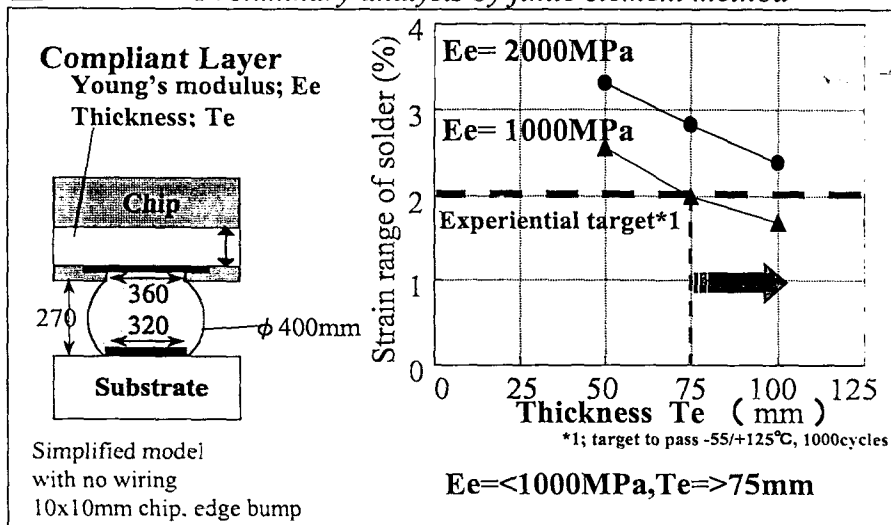
Technological key; slope by stencil printing



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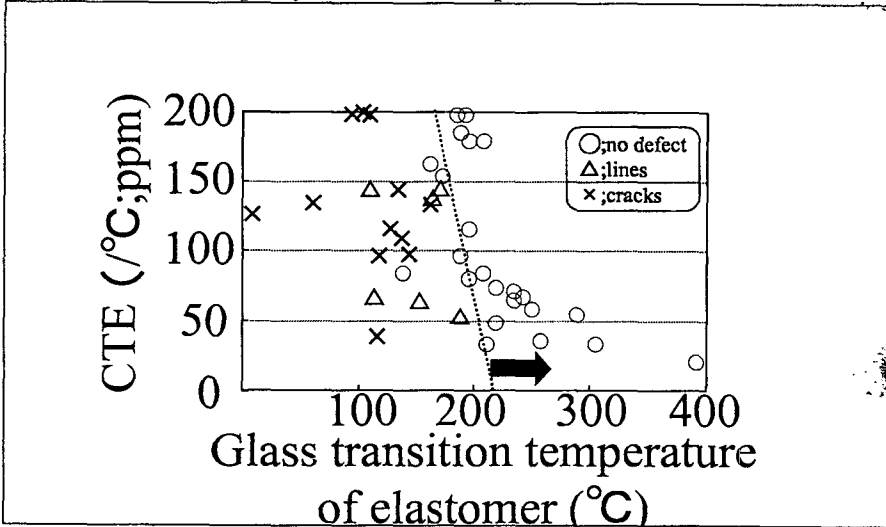
Effect of the Compliant Layer

Preliminary analysis by finite element method



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Key Point of the Compliant Layer(1)
Property to withstand sputter



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Key Point of the Compliant Layer (2)
Procedure of stencil print

metal squeegee elastomer paste

Wafer Stencil Mask

Pre-coating Coating Mask remove

Examples of results

| Paste | viscosity (Pa.s) | thickness (mm) | slope (mm) |
|-------|------------------|----------------|------------|
| X | 220 | 76□ 2 | 0.45 |
| Y | 150 | 62□ 1 | 1.44 |

Scribe line for chip dicing

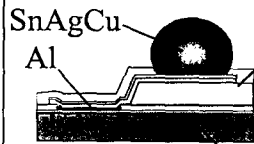
Al pad

φ0.5mm

Printed elastomer on a wafer (chip)
 Top view

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Test Vehicle for Board Level Reliability

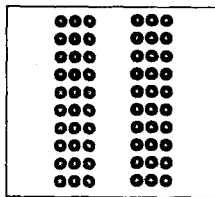


Cross Section

Material for the compliant layer

| | Young's Modulus(MPa) | | T _g | Thickness (μm) | |
|---|----------------------|------|----------------|--------------------------------|---------------|
| | -55°C | 25°C | (°C) | | |
| A | 1350 | 1040 | 198 | 74 | thermoplastic |
| B | 1290 | 1040 | 203 | 78 | thermoset |

SiO₂ on ϕ 200mm bare Si wafer (0.725mm^t)



Chip size = 9.84 × 9.27mm

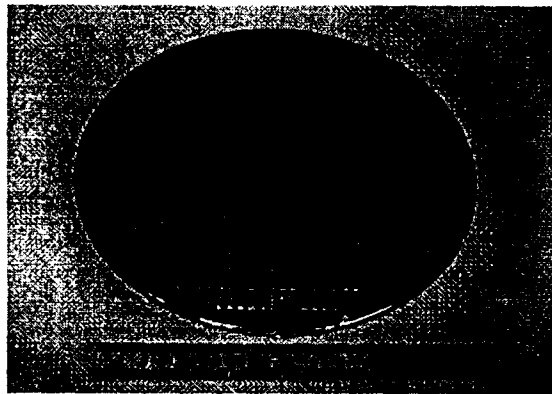
DNP = 4.66 mm

bump count = 54 (9 × 6)

bump pitch = 0.8 × 1.0mm

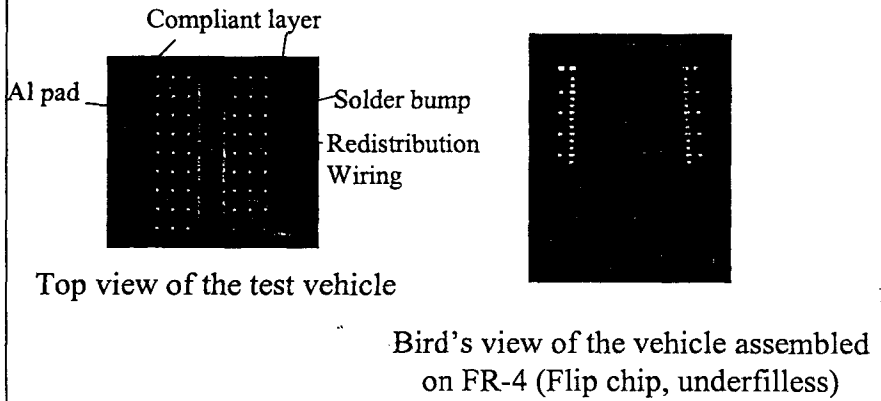
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A Wafer of WPP Phase2 *bird's view, after Au plating*



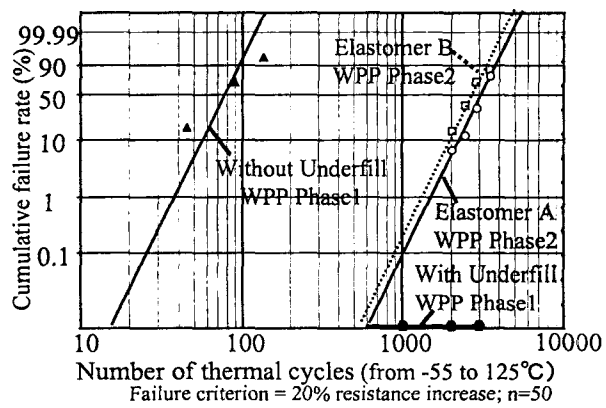
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Test Vehicle for Board Level Reliability *WPP Phase2*



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Test Result of Thermal Cycle
Board level reliability

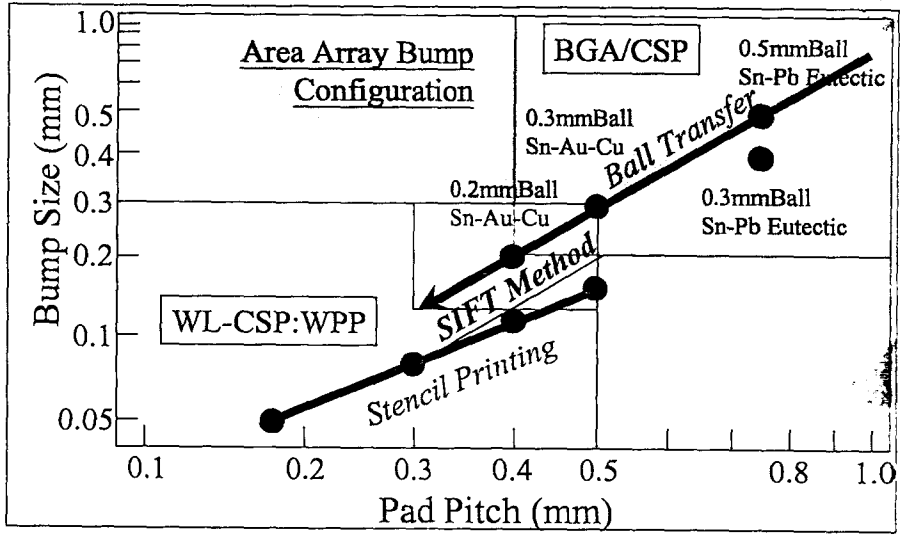


Estimated cumulative failure rate at 1,000 cycles

- Elastomer A ≐ 0.1%
- Elastomer B ≐ 0.2%

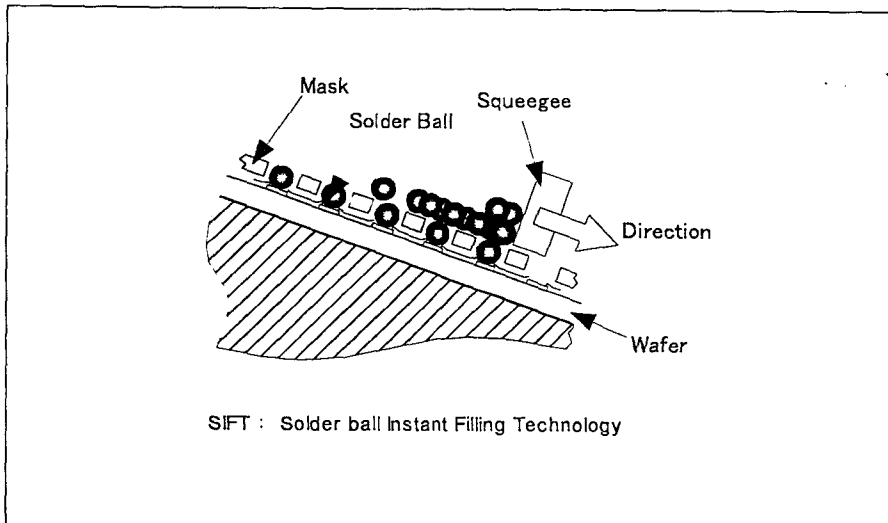
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Methodologies vs. Size/pitch in Bump Formation.



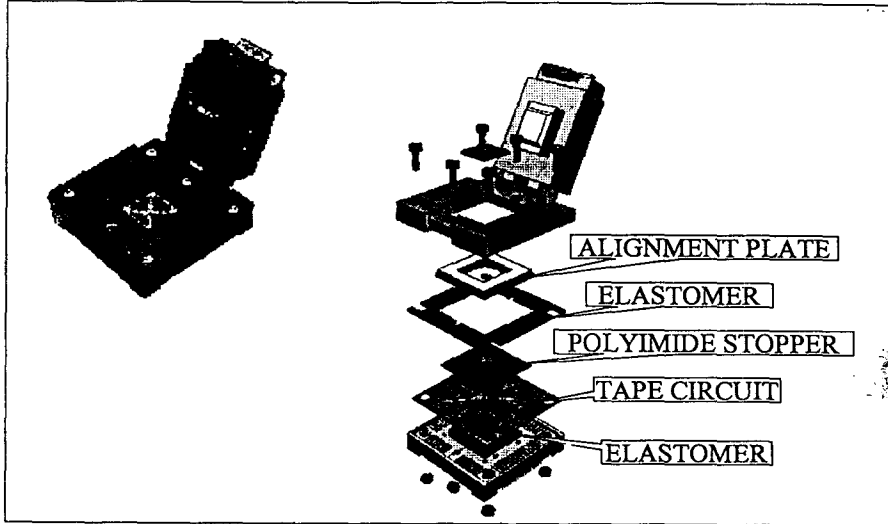
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High Volume Solder Bump Formation; *Sift*



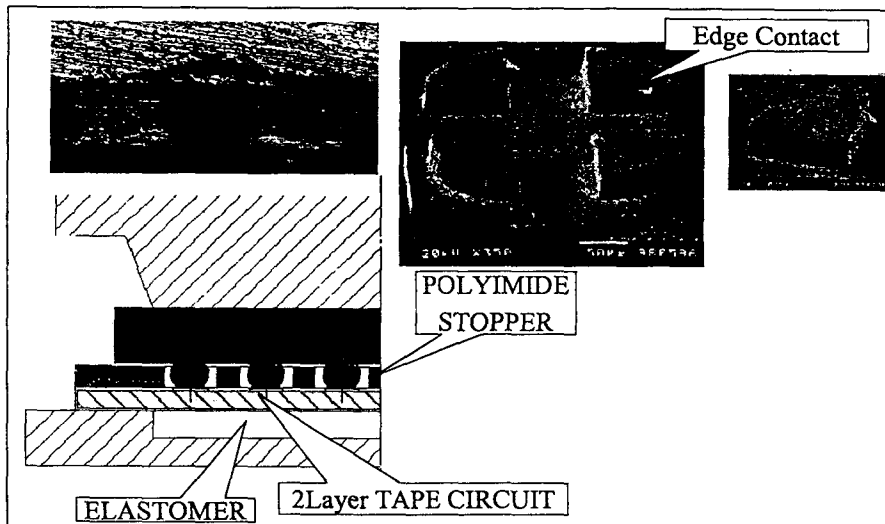
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Socket Technology



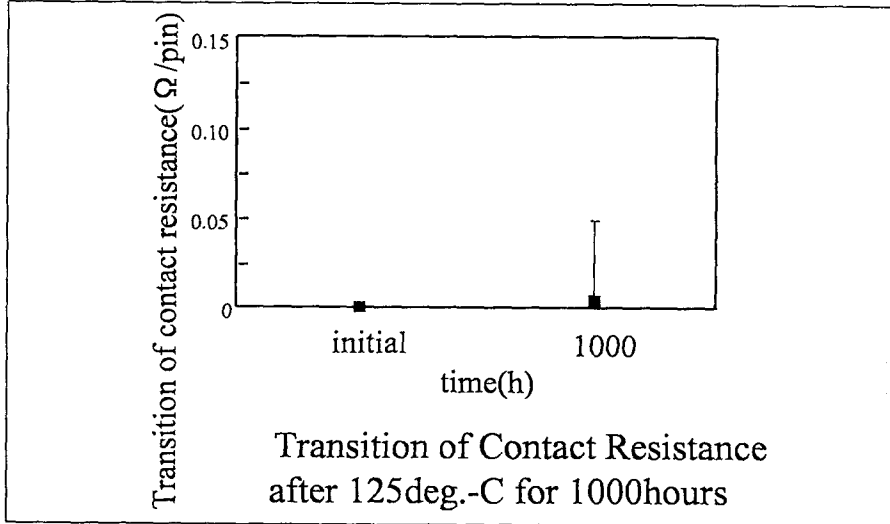
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Close Up of Edge Contact



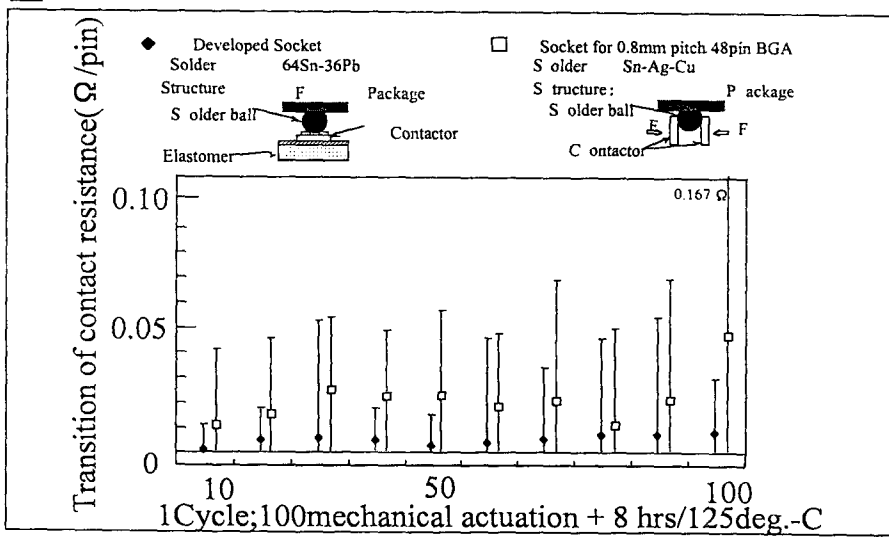
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Contact Resistance Result



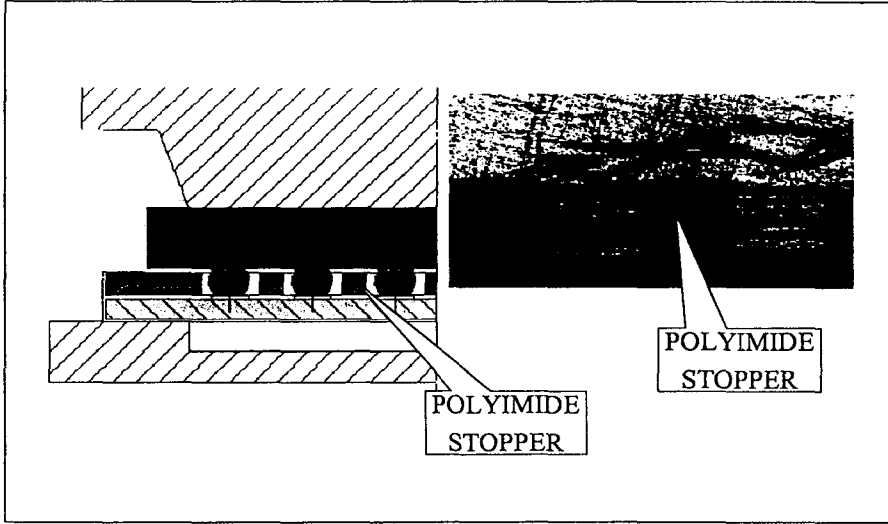
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Contact Life Time



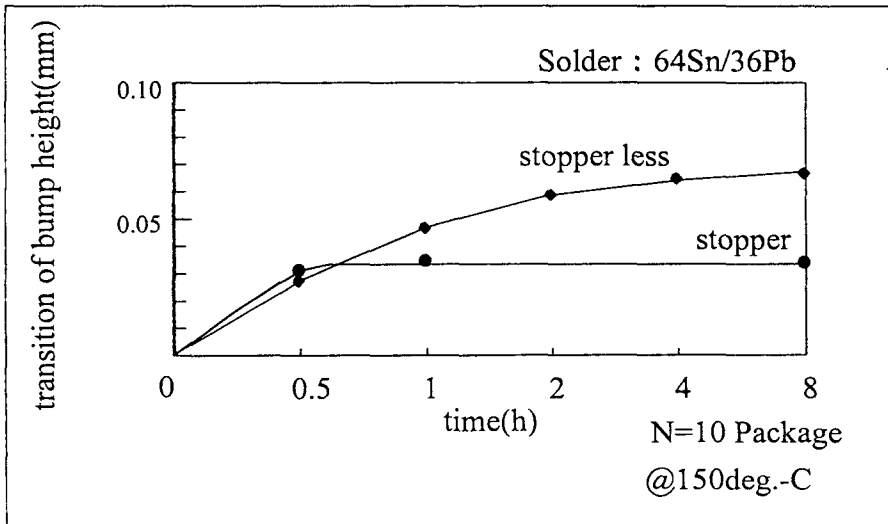
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Reduction of Solder Ball Deformation



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Transition of Bump Height



Conclusion

A WL-CSP called WPP has been developed.

1. WPP Technology

- (1) WPP1 that requires UF has been developed and demonstrated to have high reliability.
- (2) Basic technology of WPP2 with compliant layer has been developed along with synthesis of new compliant material.

2. Socket Technology

- (1) B/I socket with sheet contact has been developed for WPP.