Next Generation Solder Columns Extend Life for Large Packages for Space Applications and Data Centers

Braided Column

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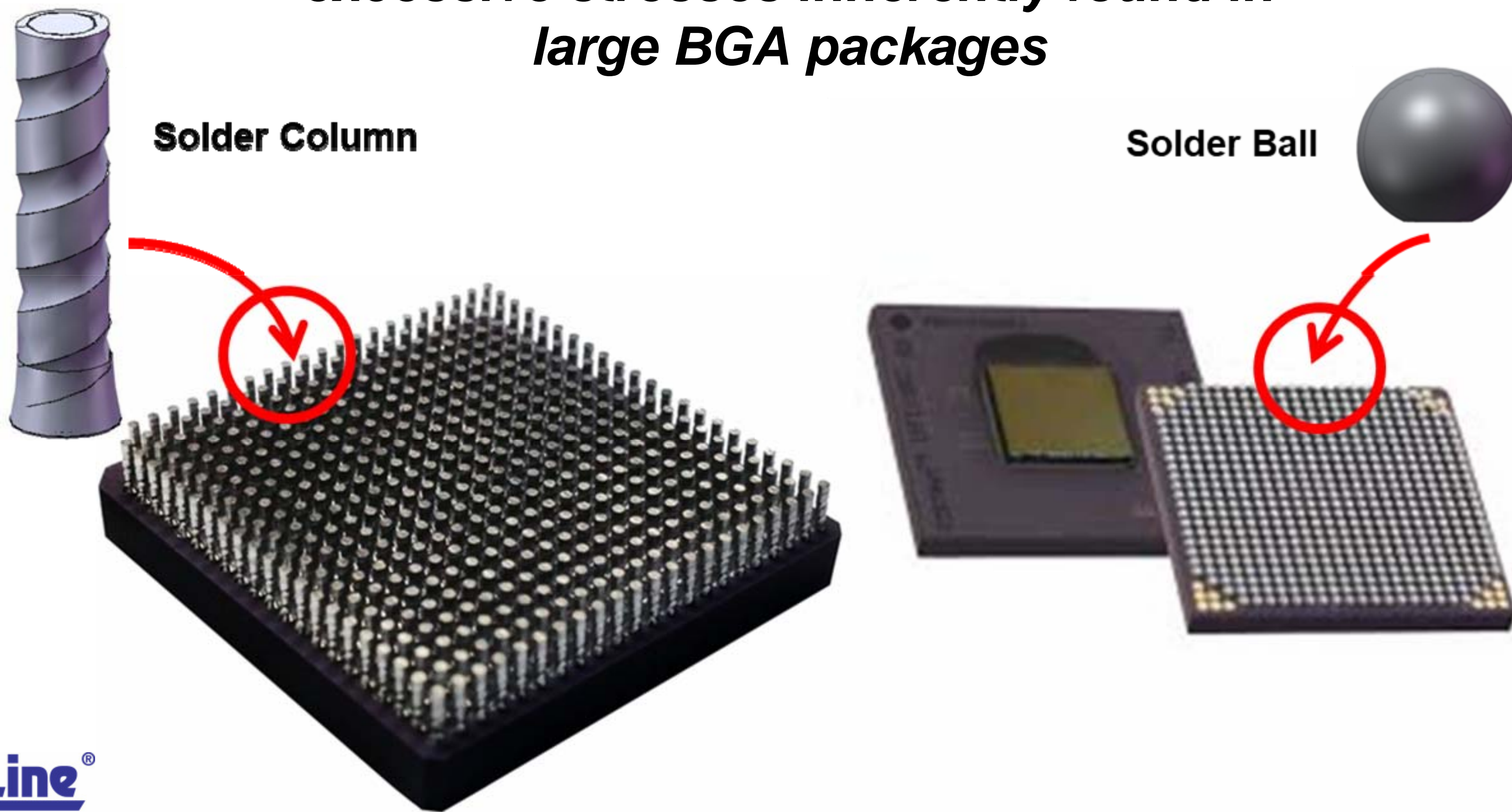
Solder balls are prone to fail (delaminate) due to excessive stresses inherently found in large BGA packages



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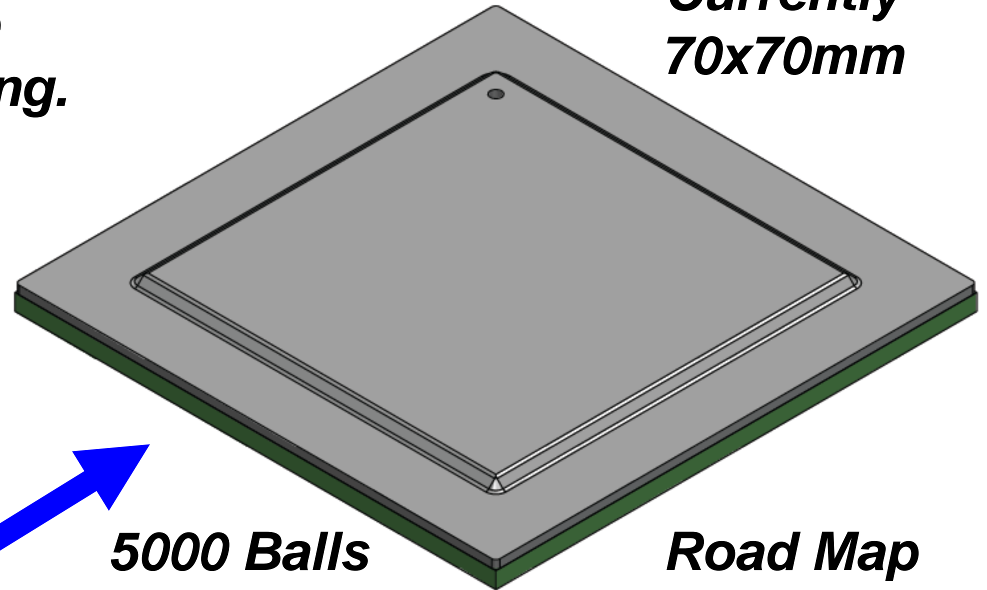
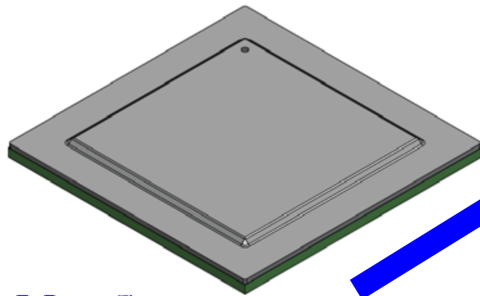
Trend is to make packages larger and larger with multiple die for AI and machine learning.

Currently 70x70mm



10 Years Ago
Size: 45x45mm



5000 Balls

Road Map
100x100mm
10,000+ balls

2000 Balls

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Package designers are constrained by available solutions to mitigate stresses inside humongous sized processors.

Typical design tricks:

- ***Copper Balancing***
- ***Low CTE Organic and Ceramic Materials***
- ***Stiffeners***
- ***Other Secret Sauce***

What if a Next Generation of Solder columns could provide a reliable solution to reduce destructive stresses?

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Heritage: ***Copper Wrapped Pb80/Sn20 Solder Columns have a 40 year track record for reducing stress in large ceramic packages for Aerospace & Defense.***

Next Generation: ***Copper Braided Copper solder columns that provide improved stress relief for very large organic and ceramic packages – Lead Free for COTS packages and Tin-Lead for Space.***

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Deep Freeze:

Quest to develop packages that can reliably operate at super low temperatures for Quantum computing as well as deep space.

Possible Solution:

Braided Solder Columns comprised of an Indium core and Niobium exoskeleton exterior capable of operating minus 150°C to minus 273°C

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Mission: *TopLine is developing next generation solder columns for new applications:*

Use for:

- *Super-Large Heterogeneous 2.5D Packages*
- *Extending Life in Ceramic Package for space*
- *Superconducting Quantum computing*
- *COTS RoHS compatible Lead Free & Tin-Lead*

Plug & Play: *Drop-in replacement for heritage copper wrapped columns and solder balls.*

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Solder Column relative size

Magnification 200X

Shown before Solder Coating

Column Length 1.0mm ~ 2.2mm

16 strands copper wire braided over a solder core

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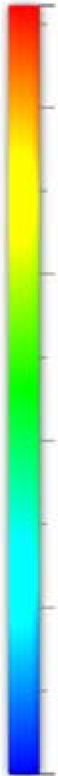
Patents:
US 10,477,698 B1
CN 1118822899 B
Planarized Braided Solder Columns

Max Strain

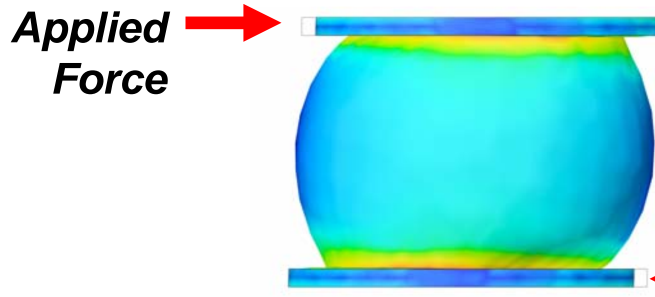


Min Strain

Finite Element Analysis Comparison Bend Strain Ball vs Column

***Observation:* Braided Columns absorb stress and distribute the load more evenly than balls.**

Applied Force



Applied Force

Applied Force

Applied Force

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Comparative Stress in Different Columns

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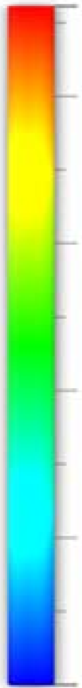
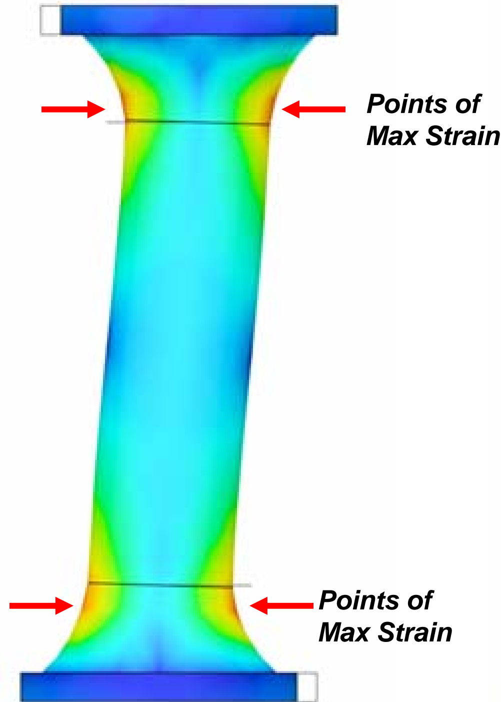
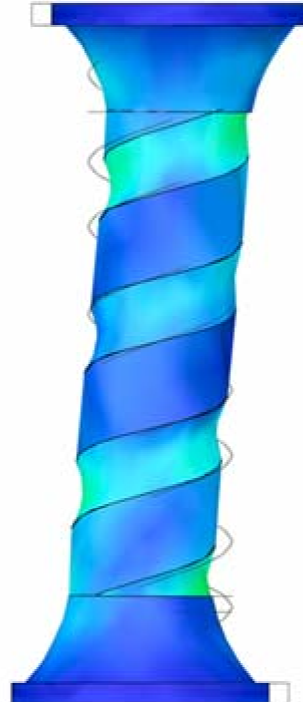
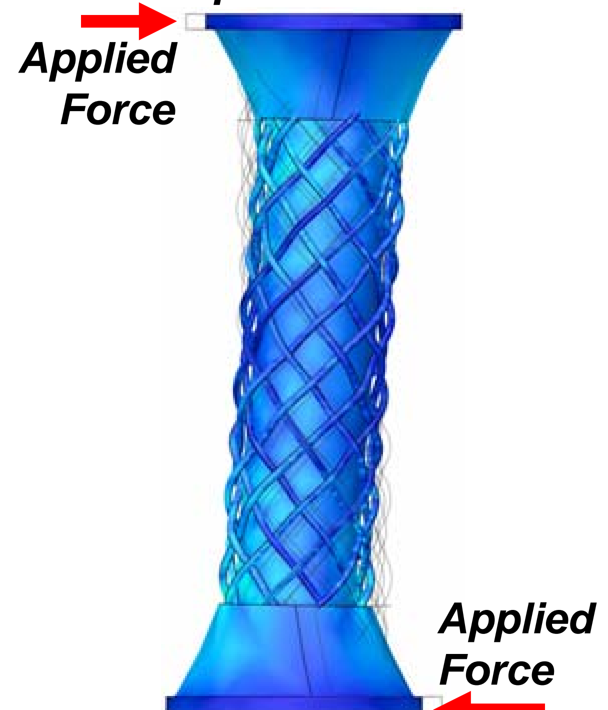




More stress = Orange/Yellow

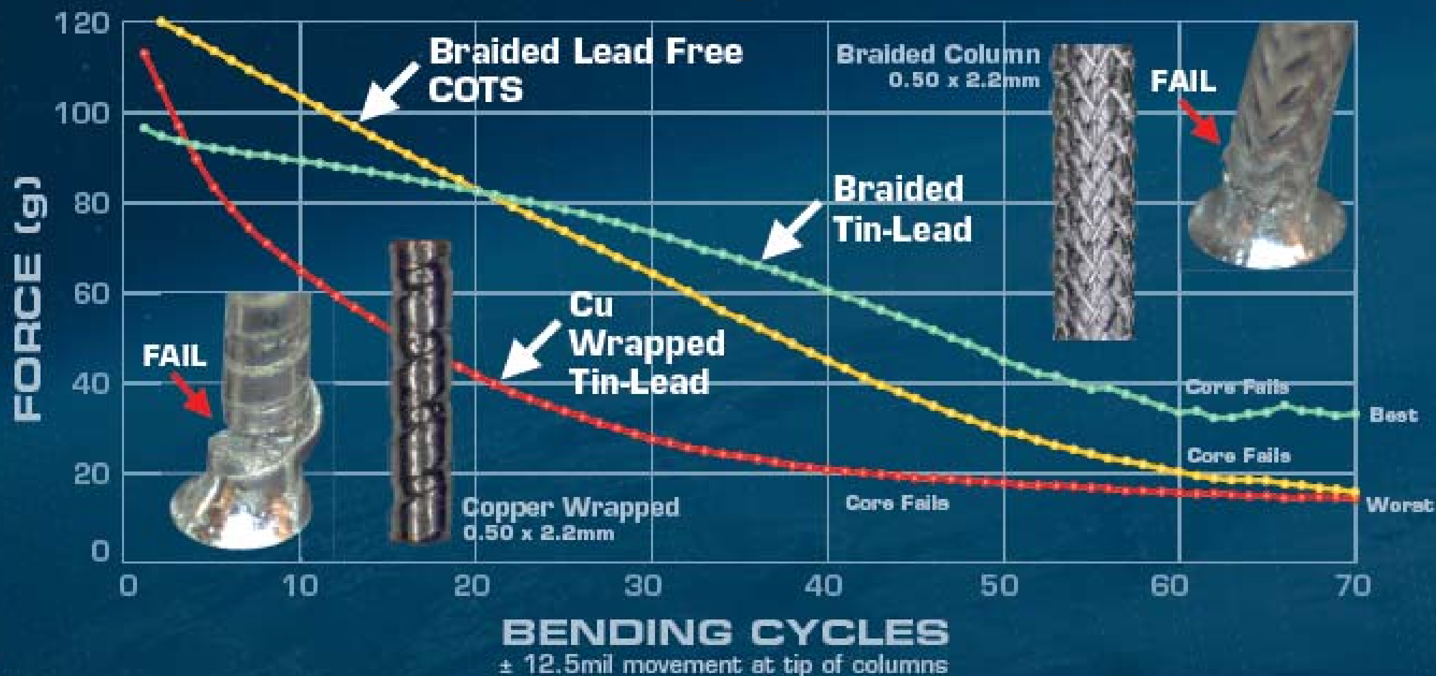


Moderate stress = Light Blue



Less stress = Dark Blue

Accelerated Bend Test
Braided vs Copper Wrap Columns



Observations:

Braided columns survive more bending than copper wrap columns.

The solder core always breaks first before the copper breaks.

Flattening of cure indicates solder core breaks.

All Columns:
0.51 x 2.21mm

Core Material:
Tin-Lead Pb80-Sn20
Lead Free SnSb

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Failure Mode: Core Breaks above the solder fillet

Braided:

Copper Wrap:

Ongoing Data Collection to Compare Braided Column Alloys and Wire Sizes:

Diameter:

- Solder Core 8 to 20mils
- Copper 1.0, 1.5 and 2.0mil

Alloys:

- Tin-Lead: Pb80, Pb90 and HMP Pb93.5
- Lead Free: Sn/Sb, SAC, Indium and other

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Problems with Heritage Copper Wrap Columns:

1. ***Package size miniaturization constrained to 1.0mm pitch.***
2. ***Narrow soldering temperature profile window during secondary reflow of chip to the PCB.***
3. ***Lead Free (RoHS) not possible using copper wrap technology.***

Benefits of Braided Solder Columns :

1. Wider (more robust) reflow soldering temperature profile window during secondary reflow of the chip to PCB.
2. Better durability and stress relief caused by CTE mismatch.
3. Smaller columns allow reduced package size 0.8mm & 0.65mm pitch and potential for reduced package mass.
4. COTS Lead Free (RoHS) as well as Tin-Lead braided columns.
5. Potential for reduced voiding in the columns (under examination).

Summary:

Braided column technology supports the trend for scaling up the size of multi-chip heterogeneous 2.5D packages to 100mm while maintaining package reliability.

Lead Free Braided Columns available for COTS and Eu RoHS applications.

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Braided Columns have potential to extend life for mission critical applications.

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