TA.TEC Engineering Insights #001

What If the Perfect Ribbon Bond Design Doesn’t Exist?

Every engineering decision comes with a trade-off.



Thermal Performance

Lower Temperature is better

Mechanical Reliability

Lower Strain is better

Ribbon Bond Geometry influences both thermal performance and mechanical Reliability, but improving one can worsen the other.

What Was Investigated?

The study analyzed how ribbon bond geometry influences:

Thermal Performance

Mechanical Reliability

Using

- Finite Element Analysis (FEA)
- Power cycling
- Thermal cycling

Design Variables

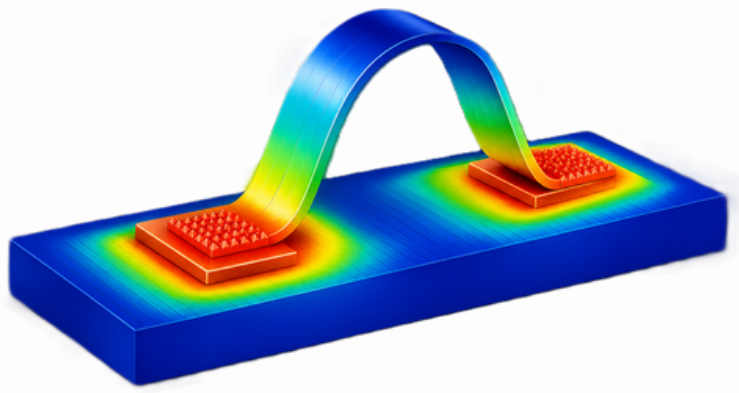
Ribbon Thickness

Loop Height

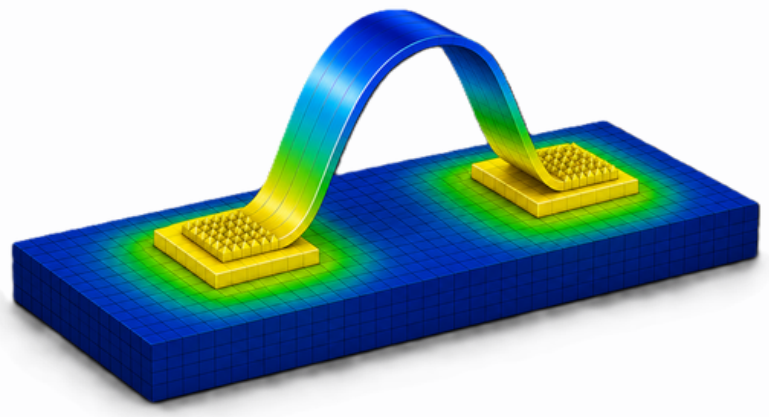
Objective
Find optimal ribbon bond design considering both objectives.



RIBBON BOND



TEMPERATURE RESPONSE



EQUIVALENT PLASTIC STRAIN

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The Engineering Trade-off

Changing ribbon geometry affects thermal performance & mechanical reliability in opposite ways.

Thermal Performance

Increasing ribbon thickness
↓ Lower ribbon Temperature

Increasing Loop height
↑ Slightly higher ribbon Temperature

Reducing ribbon thickness increases ribbon temperature significantly.

Mechanical Reliability

Increasing ribbon thickness
↑ High Equivalent plastic strain

Increasing Loop height
↑ Slightly higher Equivalent plastic Strain

Higher equivalent plastic strain indicates higher risk of fatigue and reduced reliability.

These correlations are based on **the boundary conditions** and **simulation cases** investigated in the study.
They are not **universal rules** and may vary for other applications, materials, designs or operationg conditions.

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Why There Is No Single Perfect Design

Because the objectives conflict, there is no single ribbon geometry that minimizes both.

Thermal Performance

Mechanical Reliability

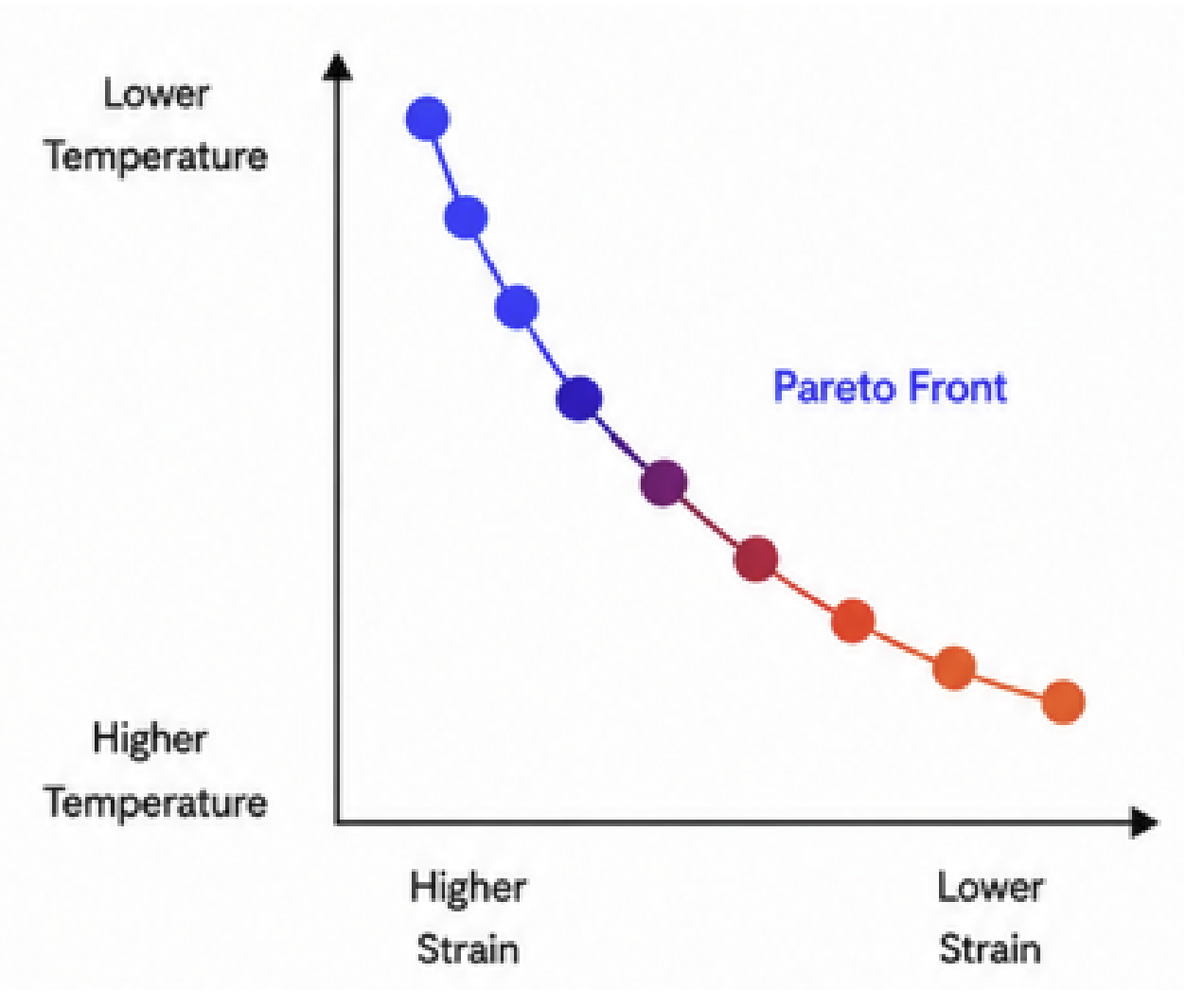
Multi Objective Optimization

↓

Generate a Pareto Front

↓

Select the design that best fits your application requirements



Key Engineering Takeaways

Ribbon geometry significantly influences thermal and mechanical behavior.

Improving one objective may compromise another.

Simulation helps to identify optimal design trade-offs before physical testing.

The final design depends on application priorities.

Engineering optimization is about balancing competing objectives - not maximizing a single parameter.

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Research behind this engineering insight

Nwanoro, K.C., Lu, H., Yin, C., Bailey, C.

An analysis of the reliability and design optimization of aluminium ribbon bonds in power electronics modules using computer simulation method

Microelectronics Reliability, 2018.

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