Optimizing Parameters for Hotformed Tailored-Blank Applications

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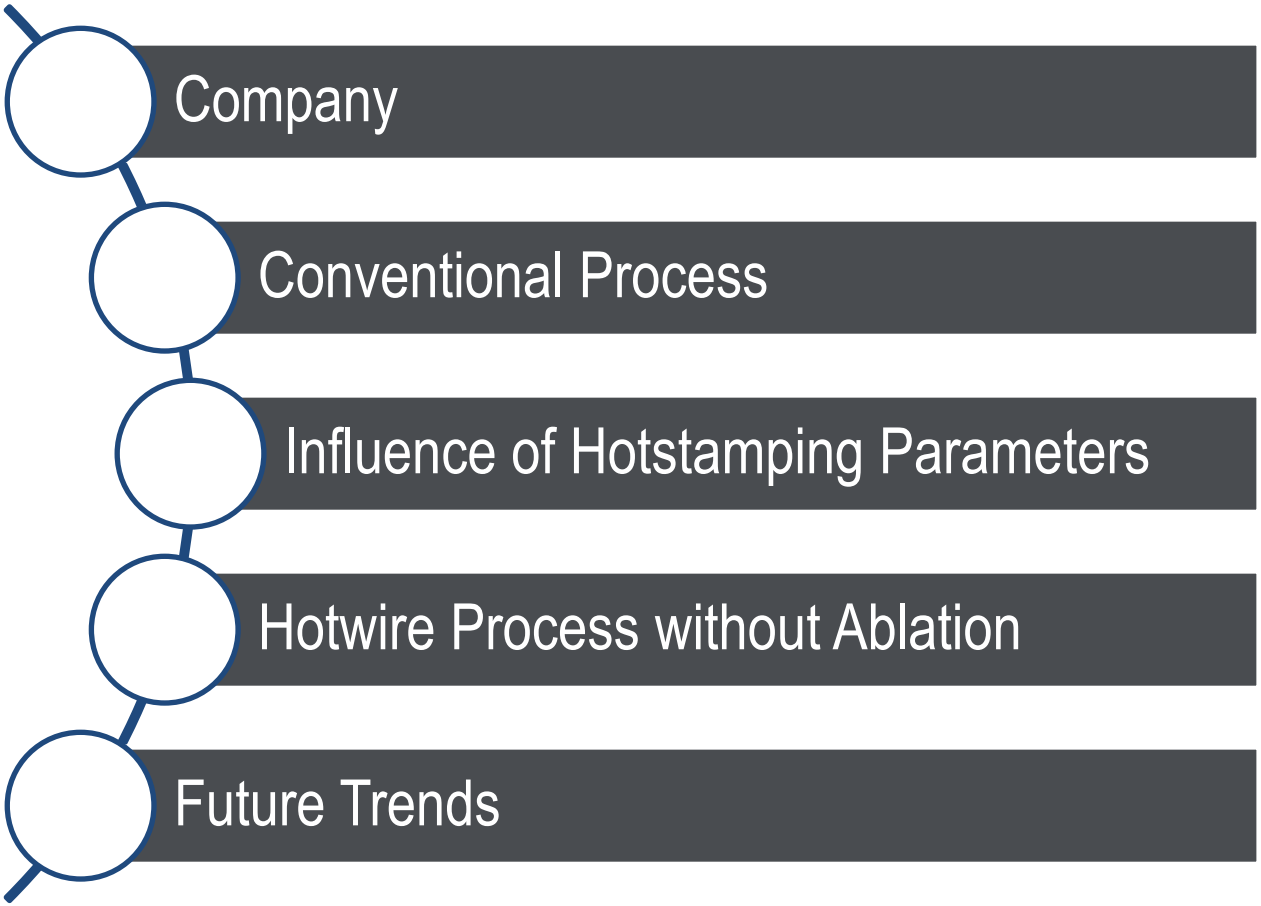
WISCO Tailored Blanks GmbH

A Worthington Steel and WISCO Tailored Blanks Joint Venture Company

WISCO tailored blanks
Inventing tomorrow – since 1985

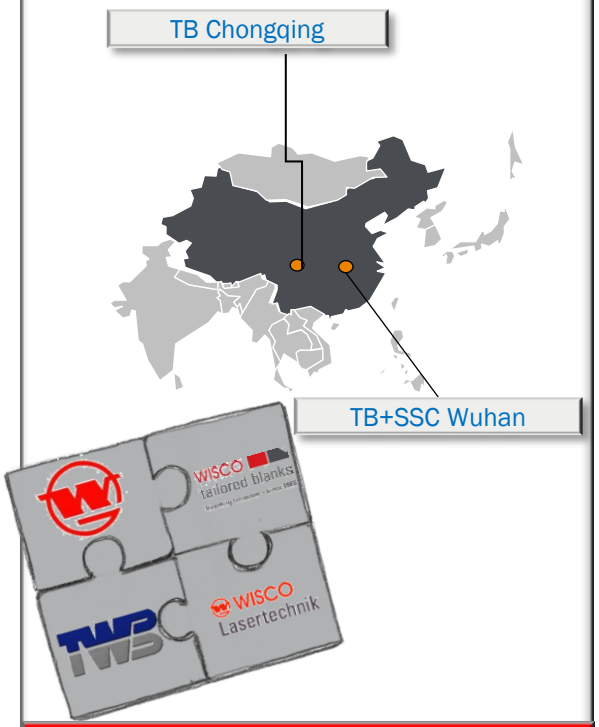
Steel Matters Demand Nothing Less
www.autosteel.org

Agenda


Company
Conventional Process
Influence of Hotstamping Parameters
Hotwire Process without Ablation
Future Trends

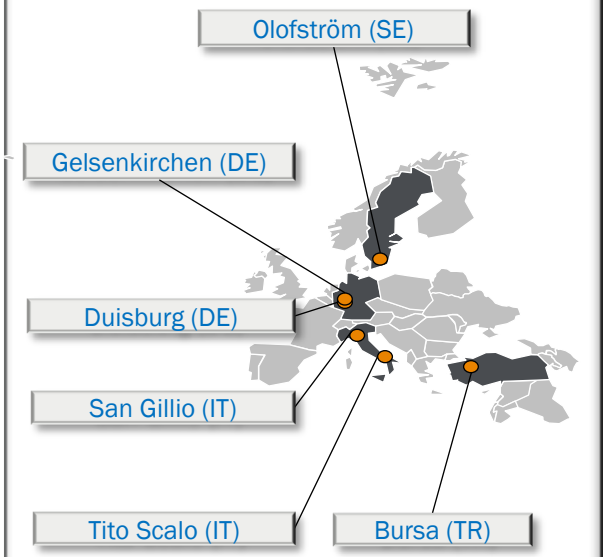
TWB & WISCO's Tailor Welded Blank Group

China



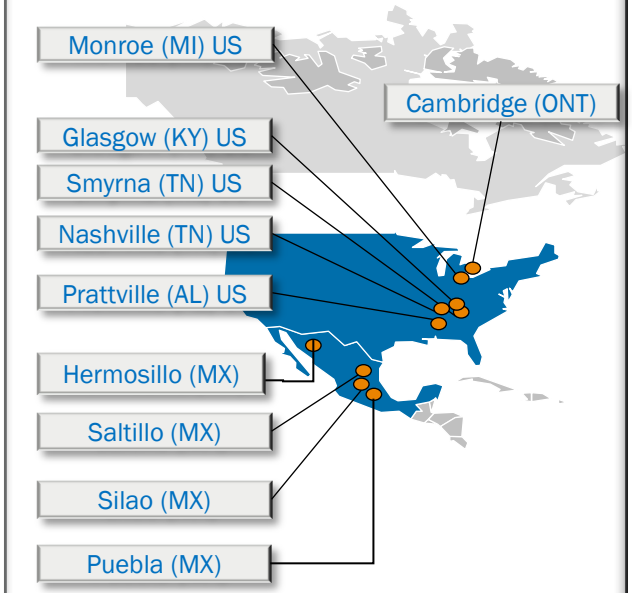
2 plants / 5 lines

Europe



6 plants / 17 lines

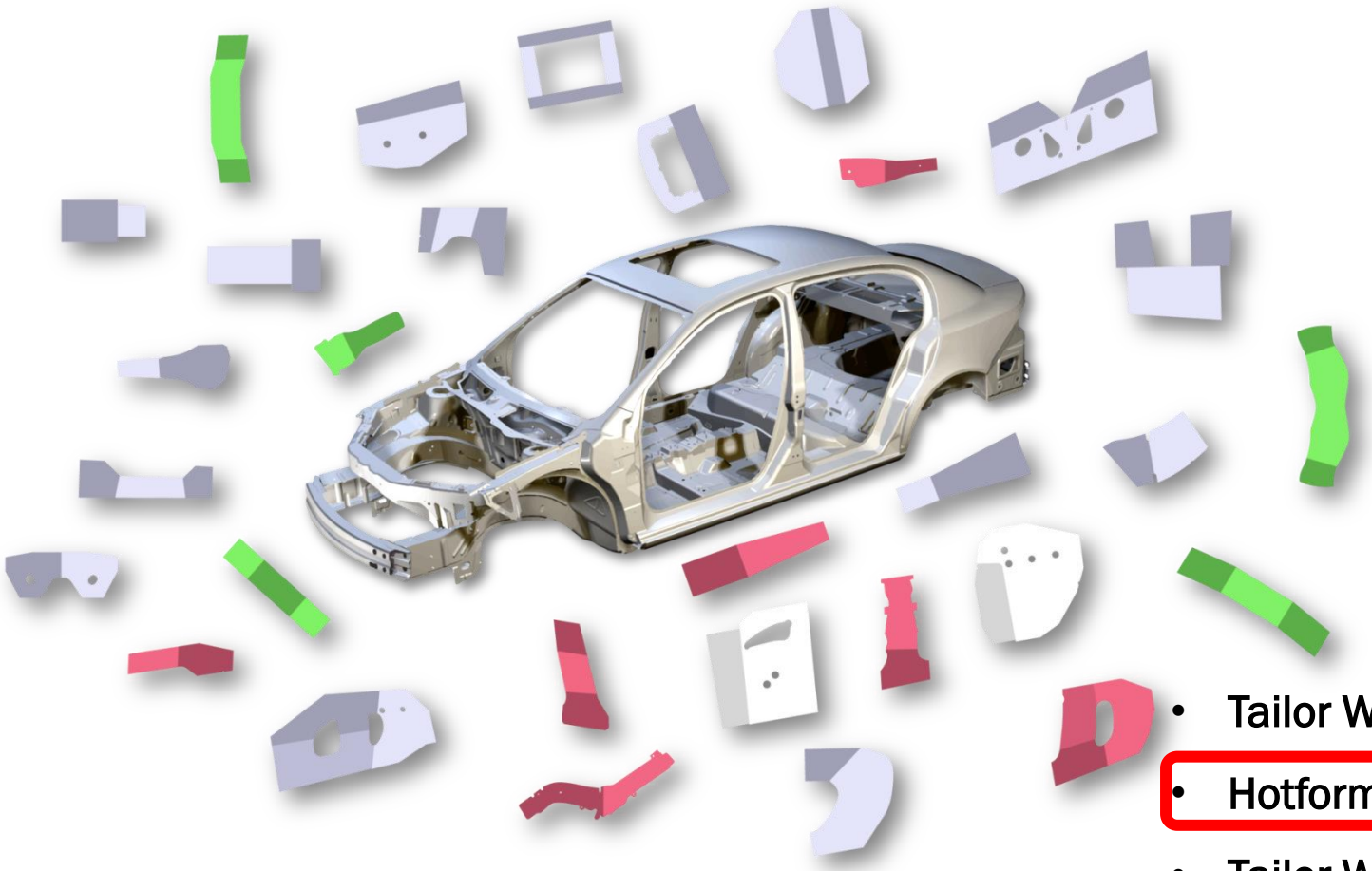
NAFTA



10 plants / 25 lines

TWB & WISCO Tailored Blank Groups support the global automotive market

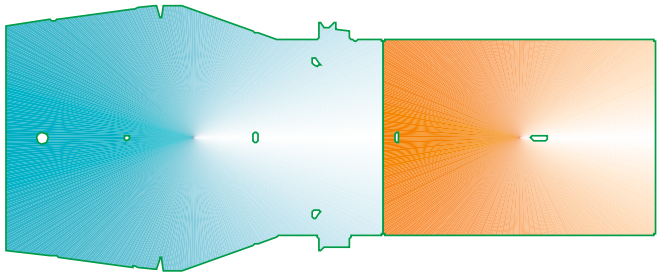
Tailored Products – 50 Products Applied



- Tailor Welded Blanks
- **Hotformed Blanks - HFTB**
- Tailor Welded Coils
- Tailored Aluminum Blanks

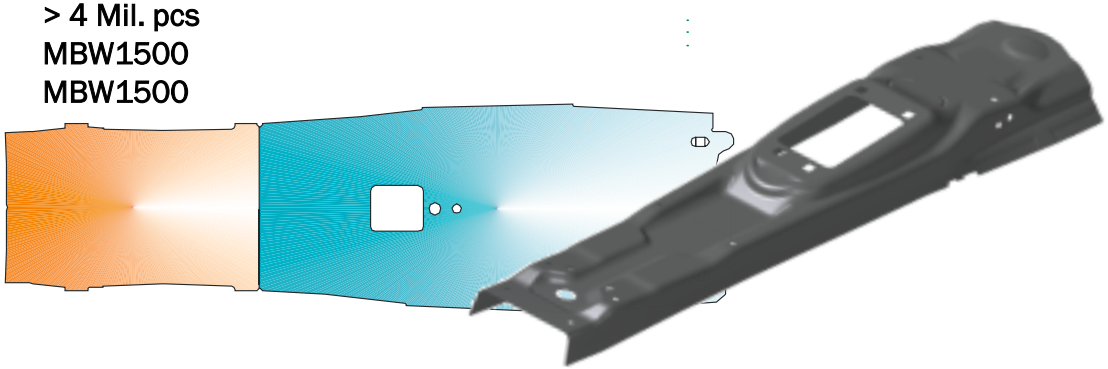
First to Market in 2007, Millions of Parts Supplied

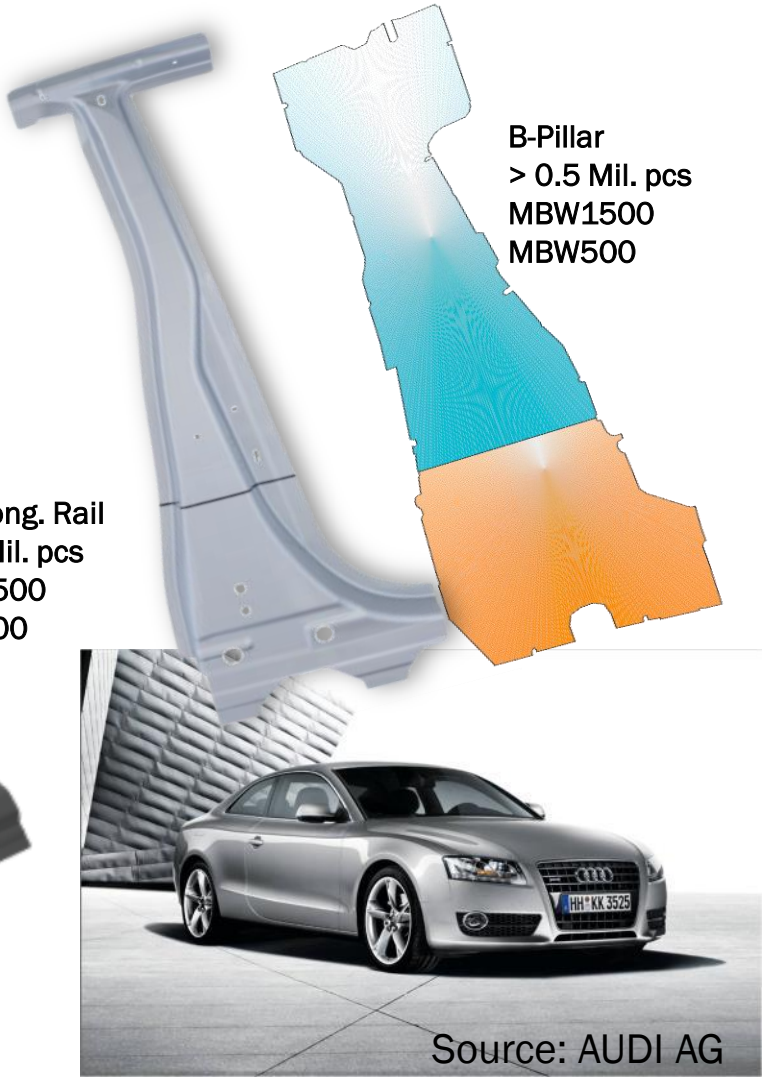
B-Pillar
> 4,5 Mil. pcs
MBW1500
MBW500



Rear Long. Rail
> 2.4 Mil. pcs
MBW1500
MBW500

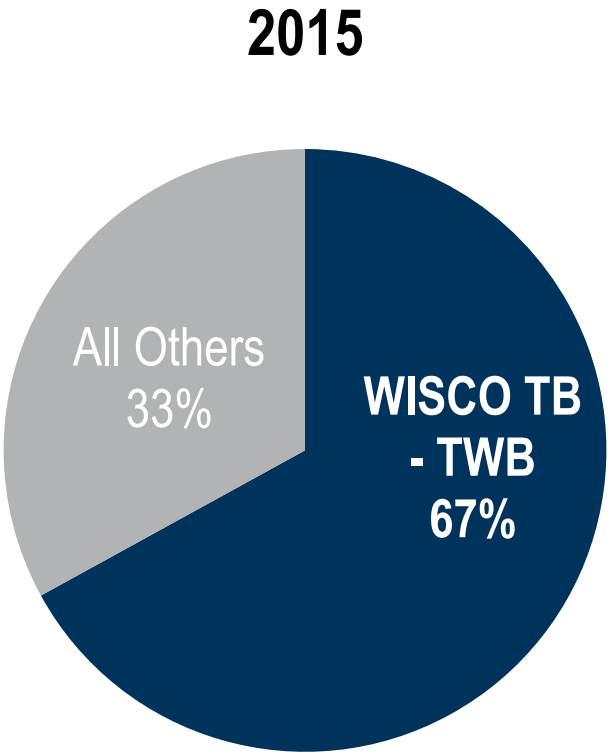
Tunnel Reinf.
> 4 Mil. pcs
MBW1500
MBW1500





B-Pillar
> 0.5 Mil. pcs
MBW1500
MBW500

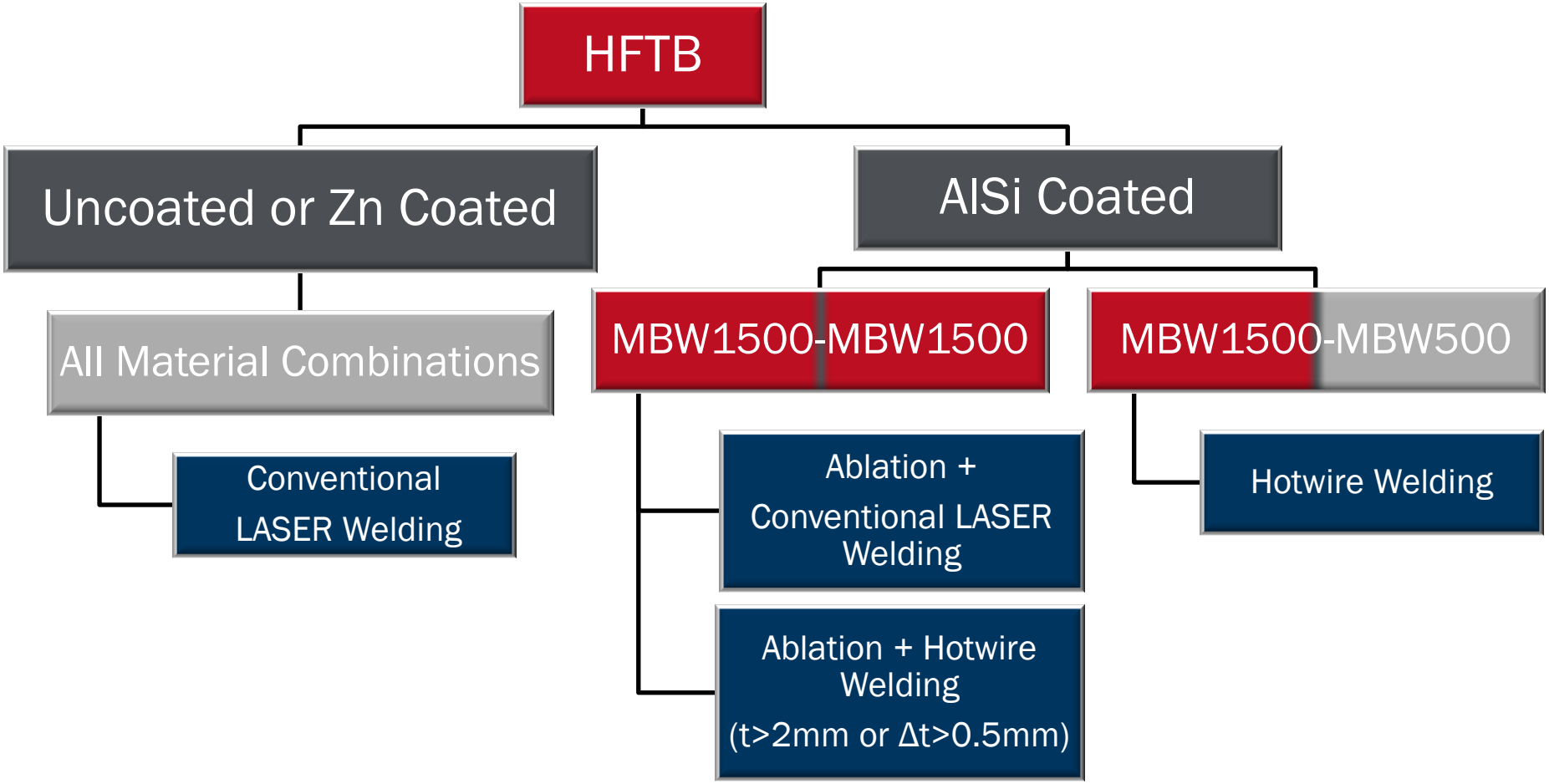
HFTB – Global Market Share



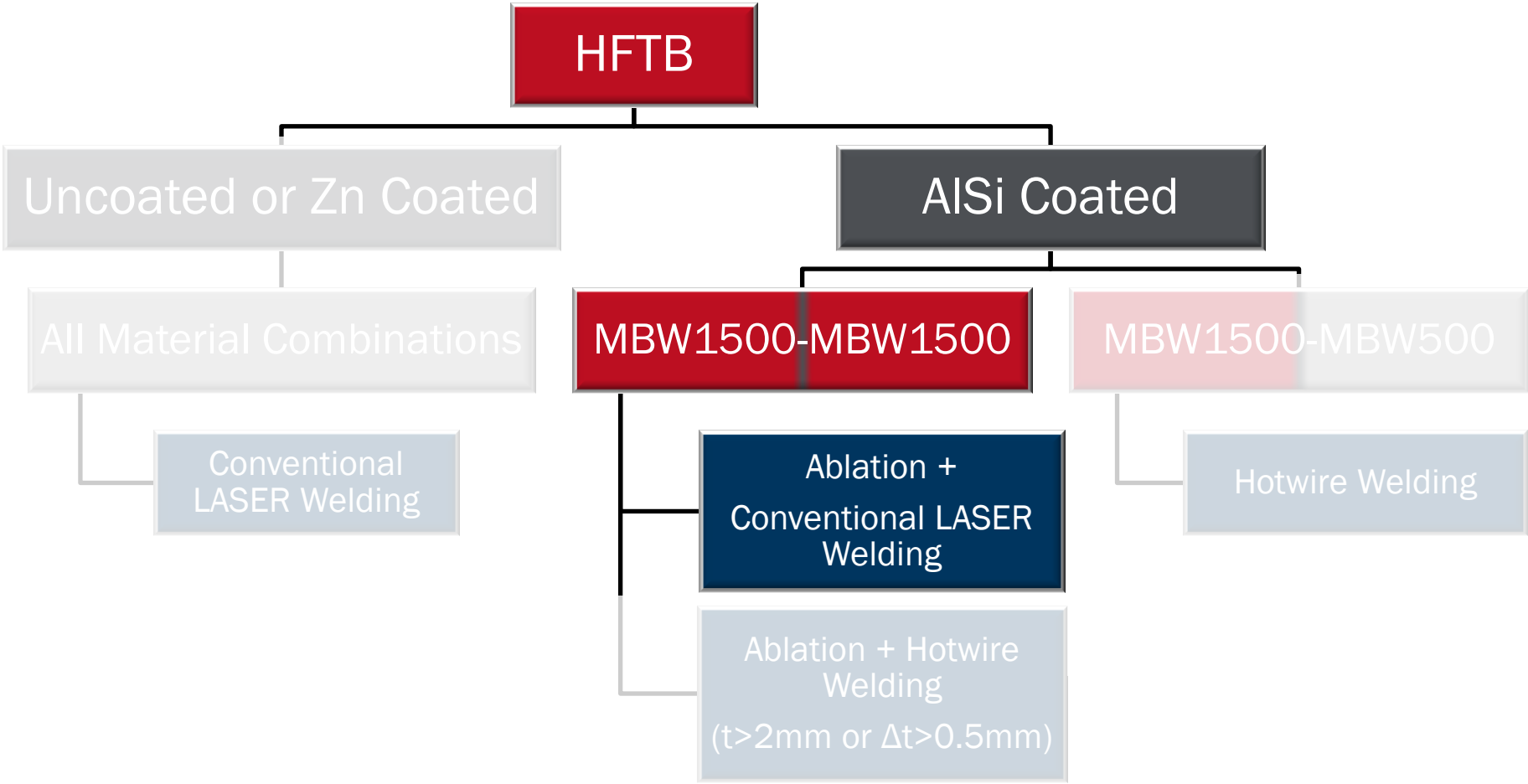
Total volume in 2015: 5.6 Million blanks

Hotformed blanks supplied since 2007: >15 Million blanks

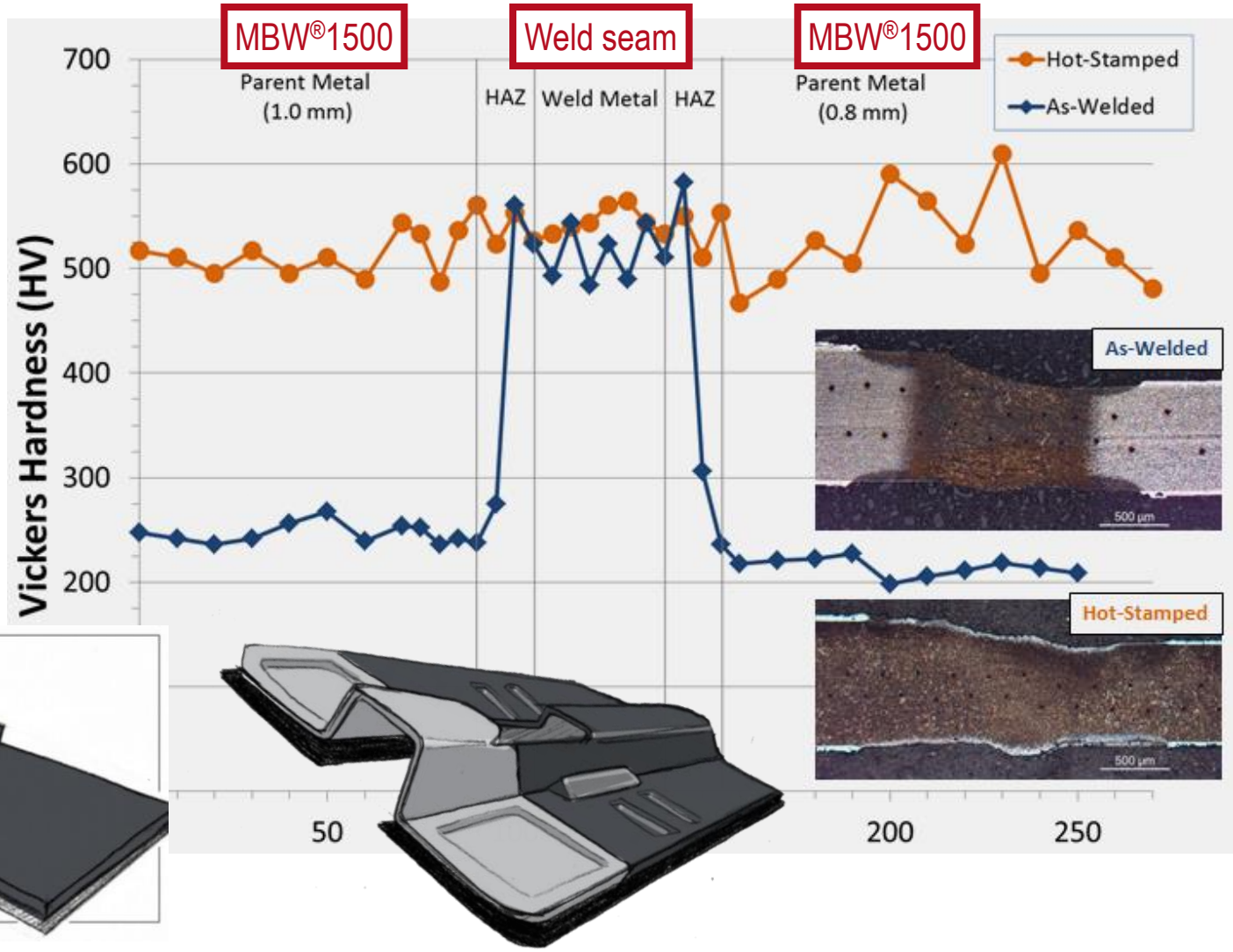
HFTB Overview

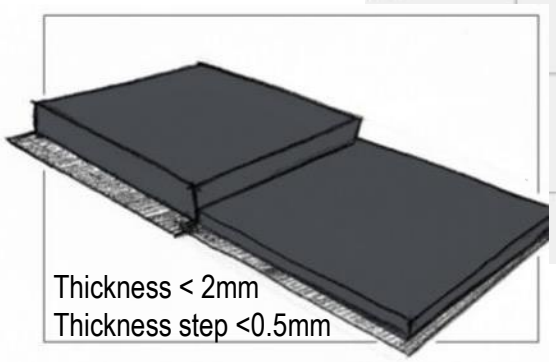


HFTB Overview



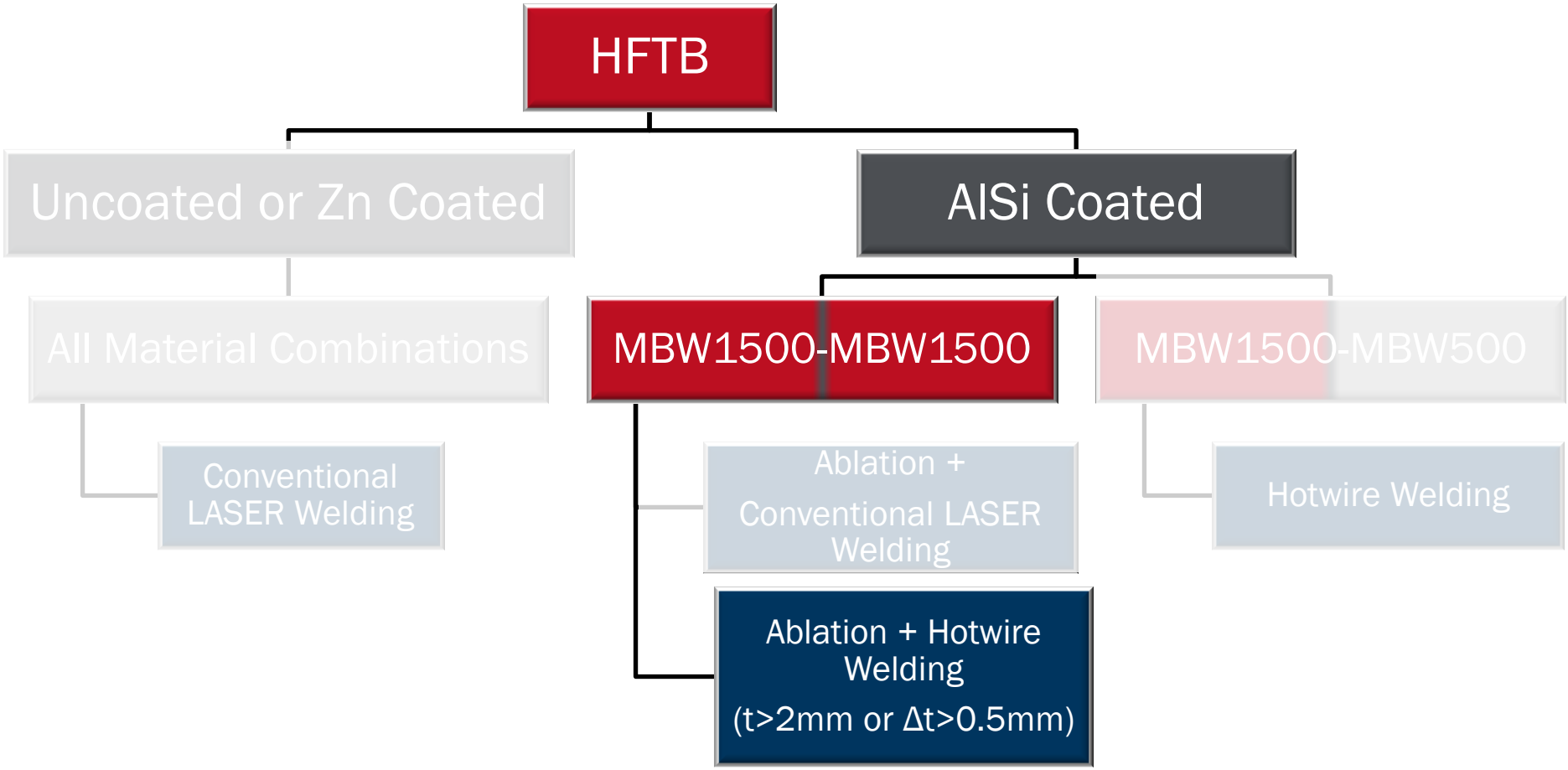
Conventional HFTB MBW1500/1500 with Ablation



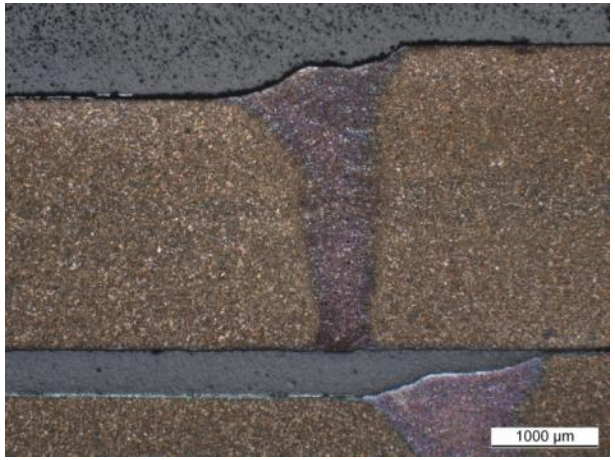


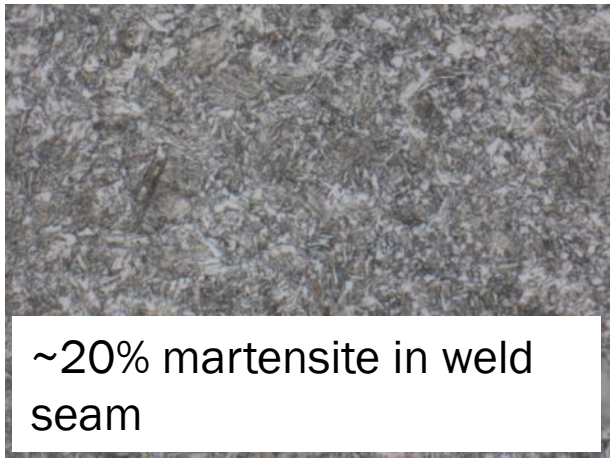
Thickness < 2mm
Thickness step <0.5mm

HFTB Overview

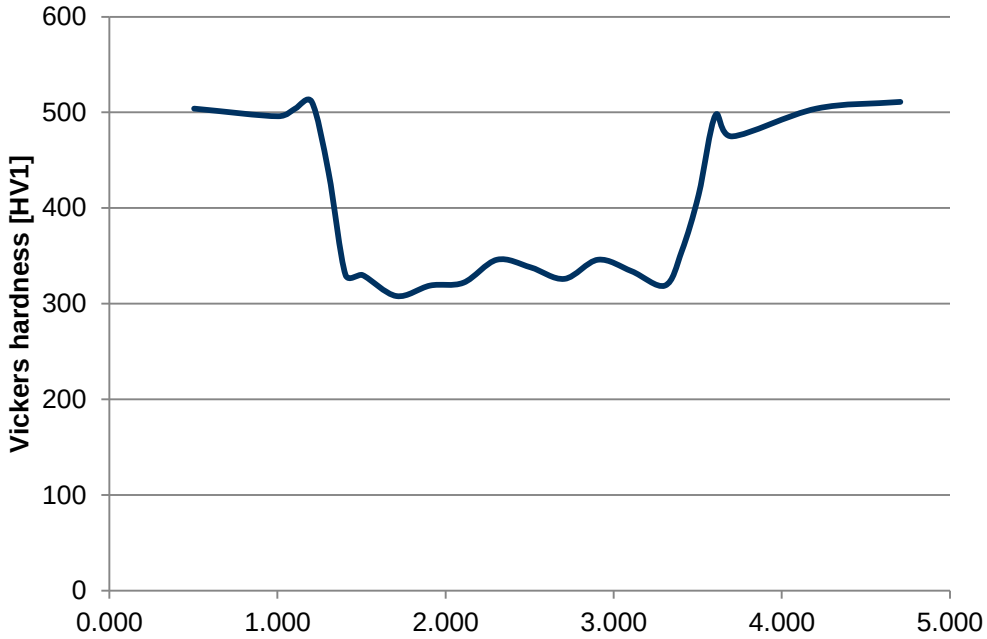


Hardness Drop Phenomenon





~20% martensite in weld seam



Phenomenon occurs due to:

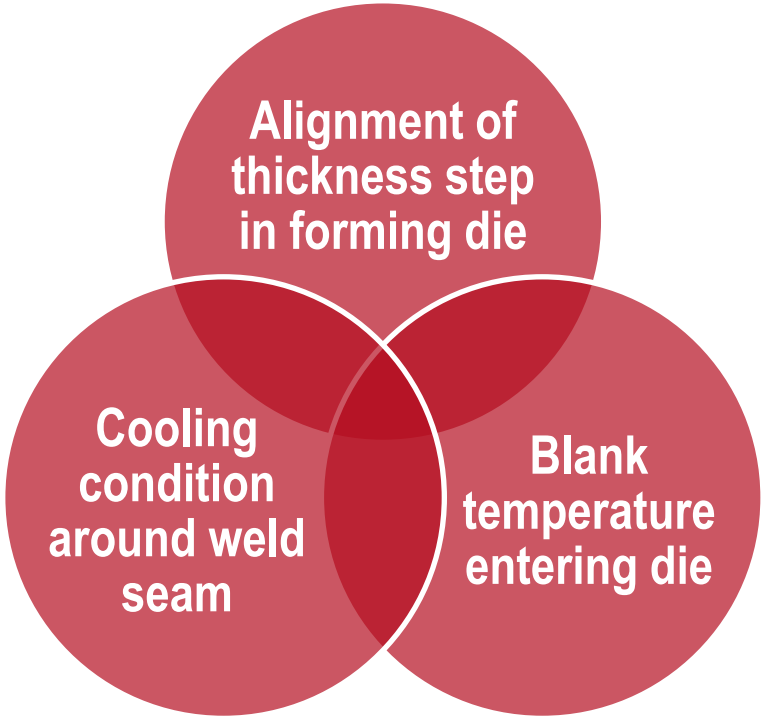
- Hotstamping process variation
- Thick material (>2mm)
- Large thickness step (Δt>0.5mm)

Reasons for Hardness Drop

Welding process

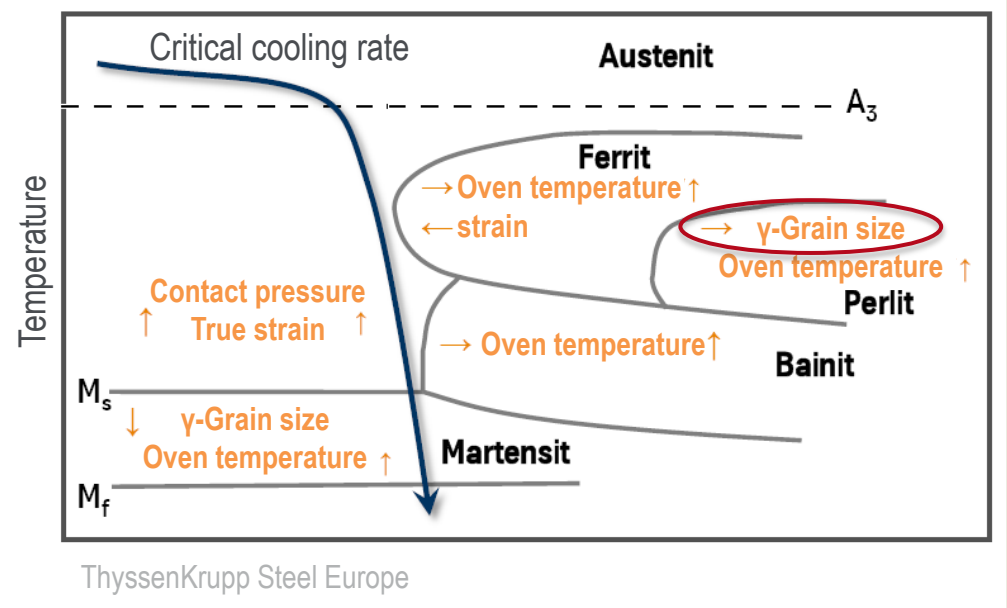
Grain size of weld seam – very small grain size due to laser welding

Hot stamping process



Weld Seam Grain Size

LASER welding process produces much finer grain size in weld zone than in base material.

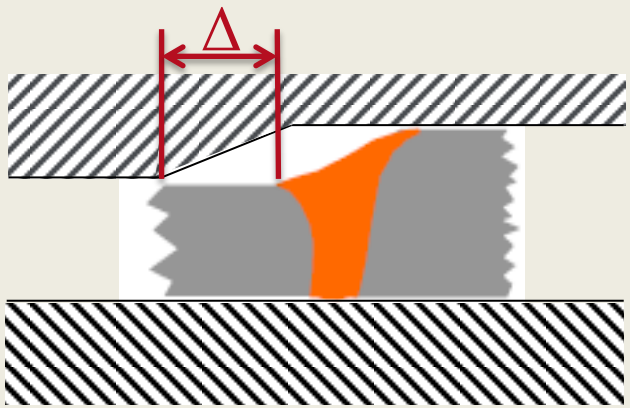


Smaller grain size lowers the martensite start temperature and shifts the Ferrite, Pearlite and Bainite "nose" to the left. Thus, less than critical cooling rates lead to ferritic or bainitic transformation.

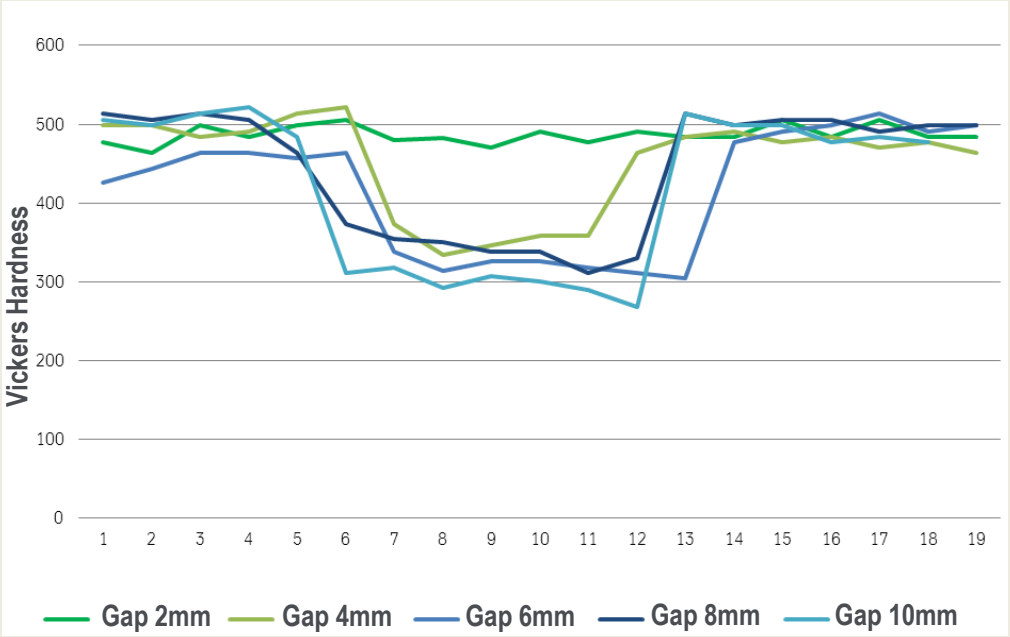
The weld zone is still hardenable.
Cooling in oil always leads to a martensitic structure of the weld zone.

Alignment of Thickness Step

Cooling rate depends on form lock in hot stamping tool.



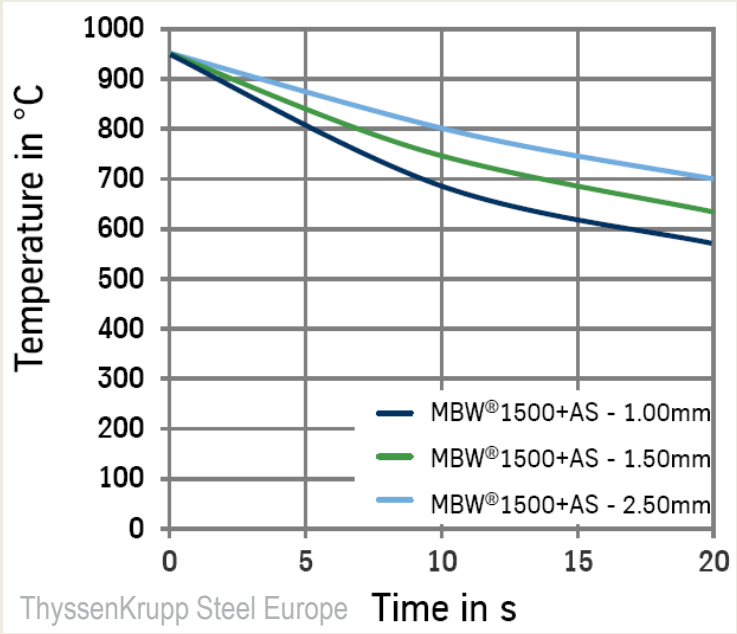
Compared to other solutions: TBs better positioned due to high geometry tolerances and abrupt thickness step



Misalignment Δ of thickness step leads to lower cooling rates in area of weld seam due to air insulation. A hardness drop can occur with a 4 mm misalignment . Misalignment greater than 4 mm can influence hardness of the base material.

Blank Temperature and Transfer Time

Low blank temperature and long transfer time can lead to ferritic transformation before stamping.

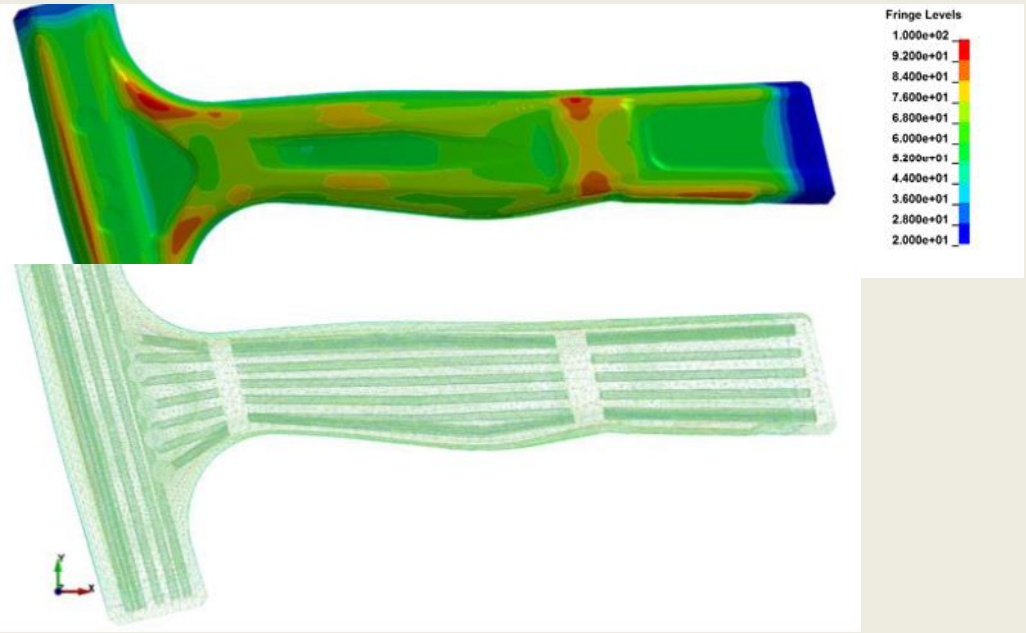


Especially for thin sheets, the blank temperature after transfer into the die can be below 700°C depending on oven temperature and transfer time.

Quenching parameters should be designed for the thinnest sheet.

Cooling Condition Near Weld Seam

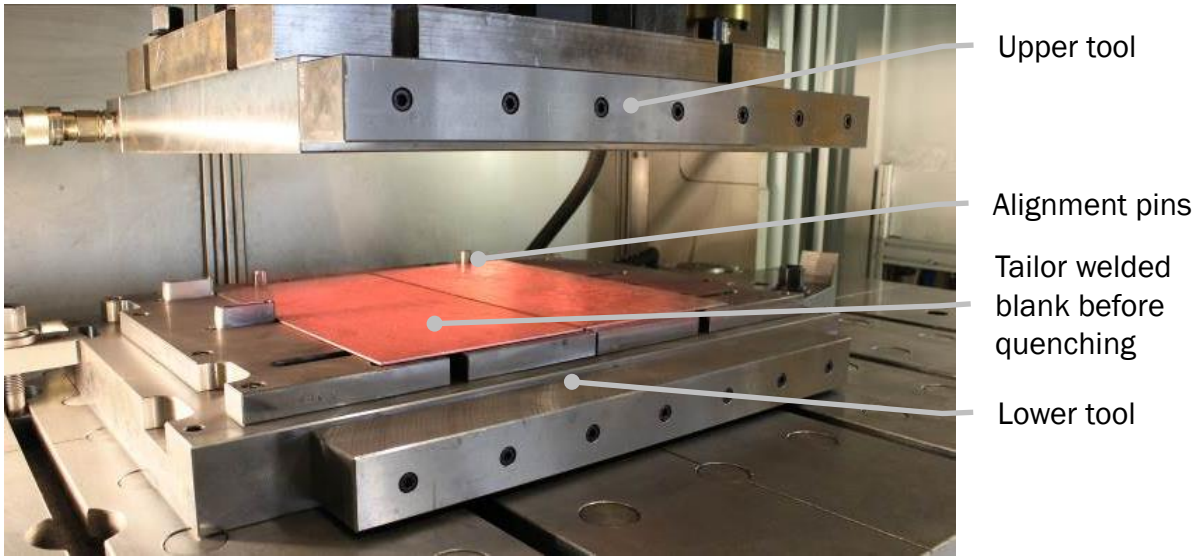
Hot spots can arise at segmented partitions of the die.

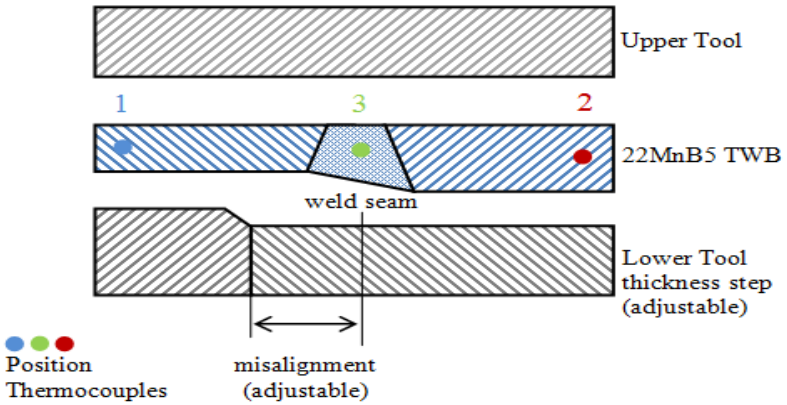


Weld seams should not be placed at possible hot spots, such as those that originate from segmental partition or lifter positioning.

Test Setup and Matrix

- Thickness combinations
  - 1.47 – 1.33 mm
  - 1.75 – 1.36 mm
  - 1.36 – 0.97 mm
- Oven temperatures:
  - 940°C
  - 870°C
- Transfer times:
  - 9 s
  - 13 s
- Misalignment:
  - 2 mm
  - 6 mm

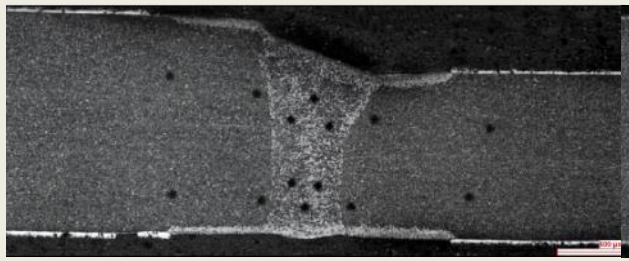




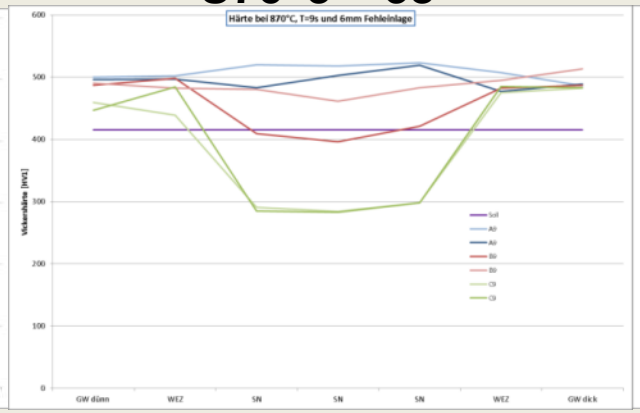
Hotforming Process Parameters

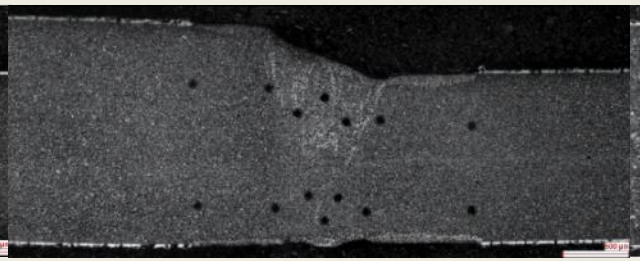
Low oven temperature and/or long transfer times can result in low blank temperature upon entering the die and lead to ferritic or bainitic transformation.

870°C – 13s

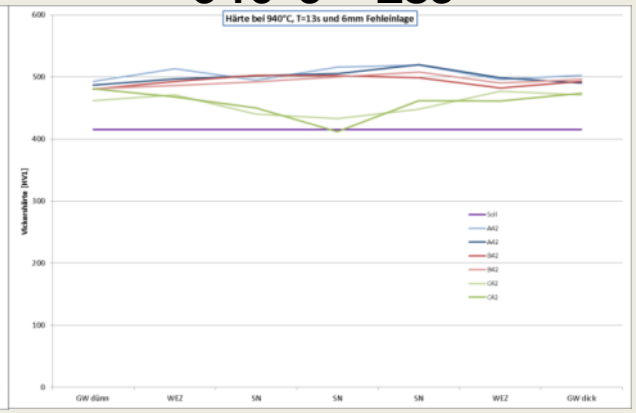


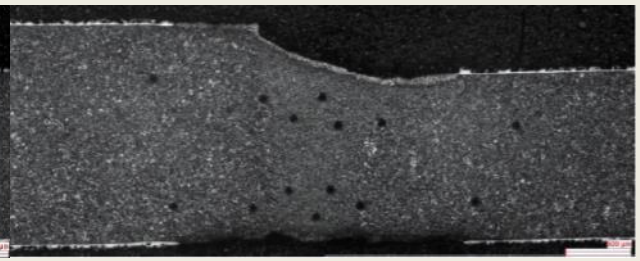
870°C – 9s





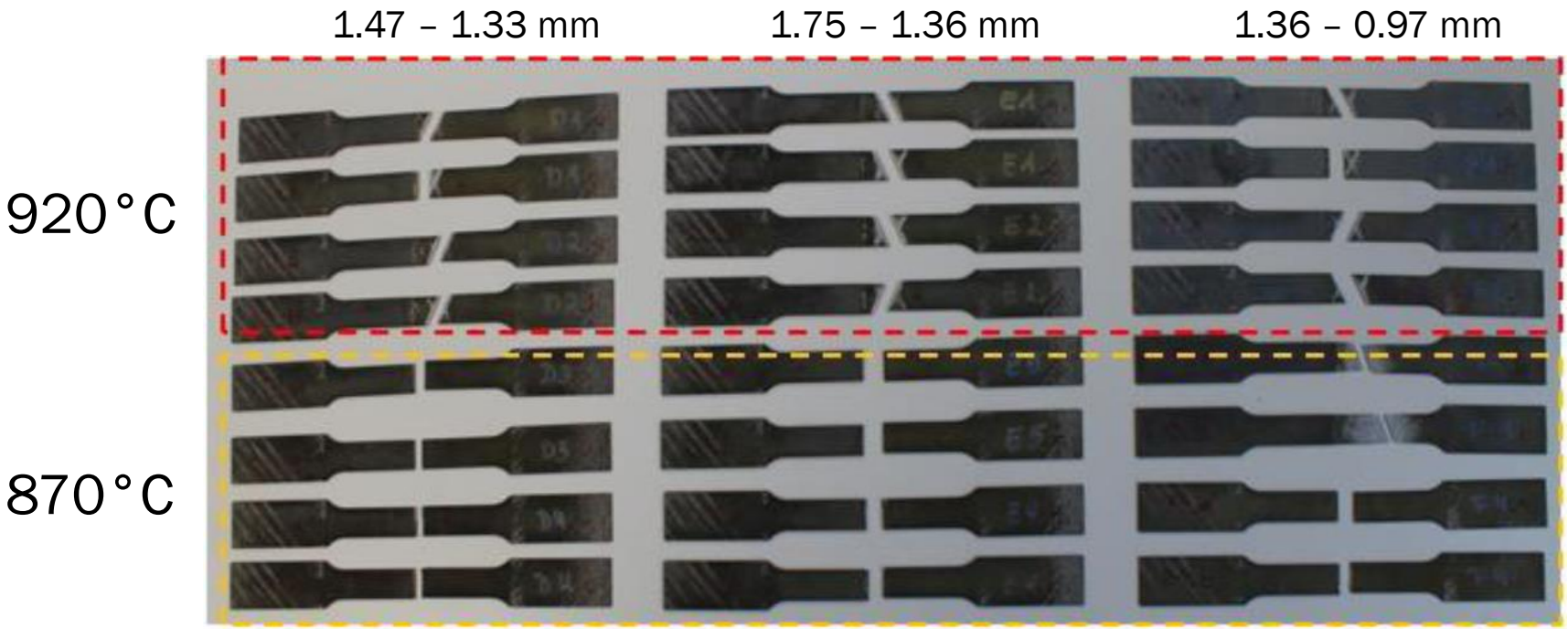
940°C – 13s



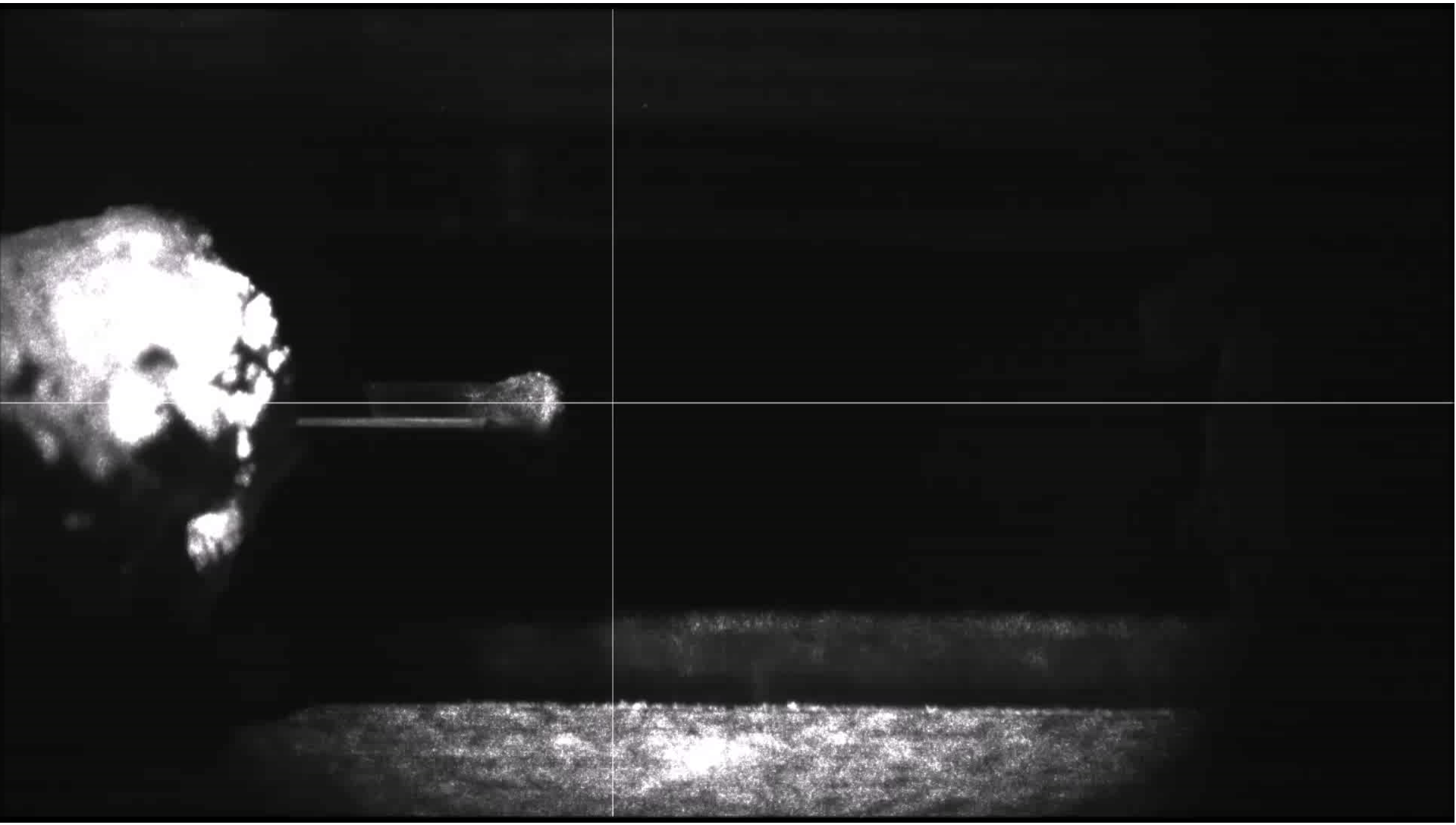


Hotforming Process Parameter – Oven Temperature

Low oven temperature results in predominant failure of weld seam in tensile test.
Regular oven temperature results in predominant failure of thin parent material.



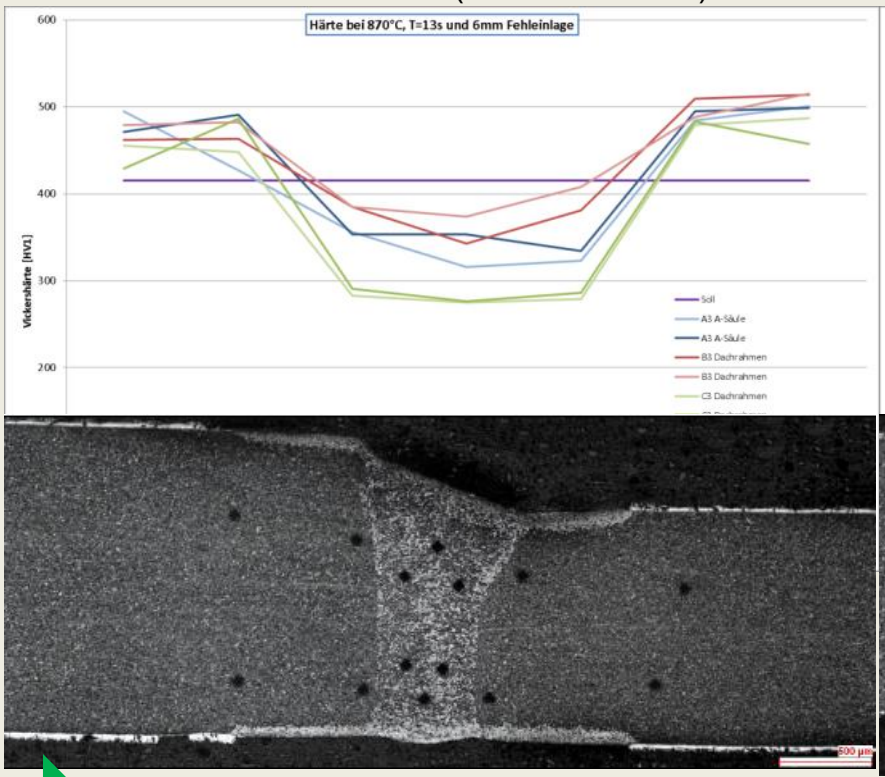
Thick HFTB MBW1500/1500 Ablation + Hotwire



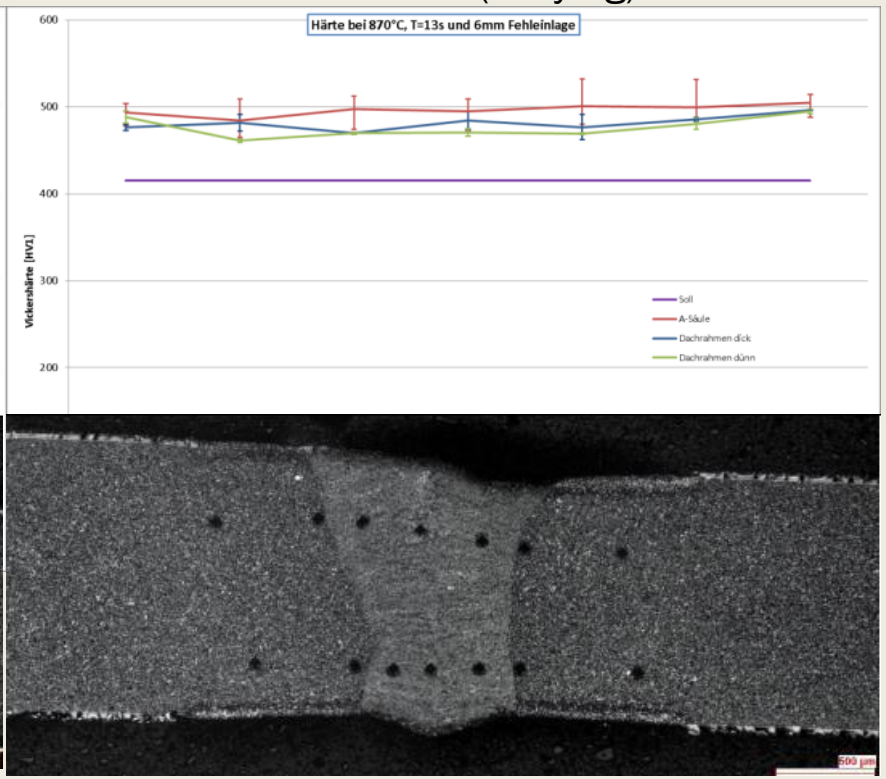
Thick HFTB MBW1500/1500 Ablation + Hotwire

Alloying of the weld seam opens process window for thick Hotformed tailored blanks.

870 °C – 13s (Conventional)

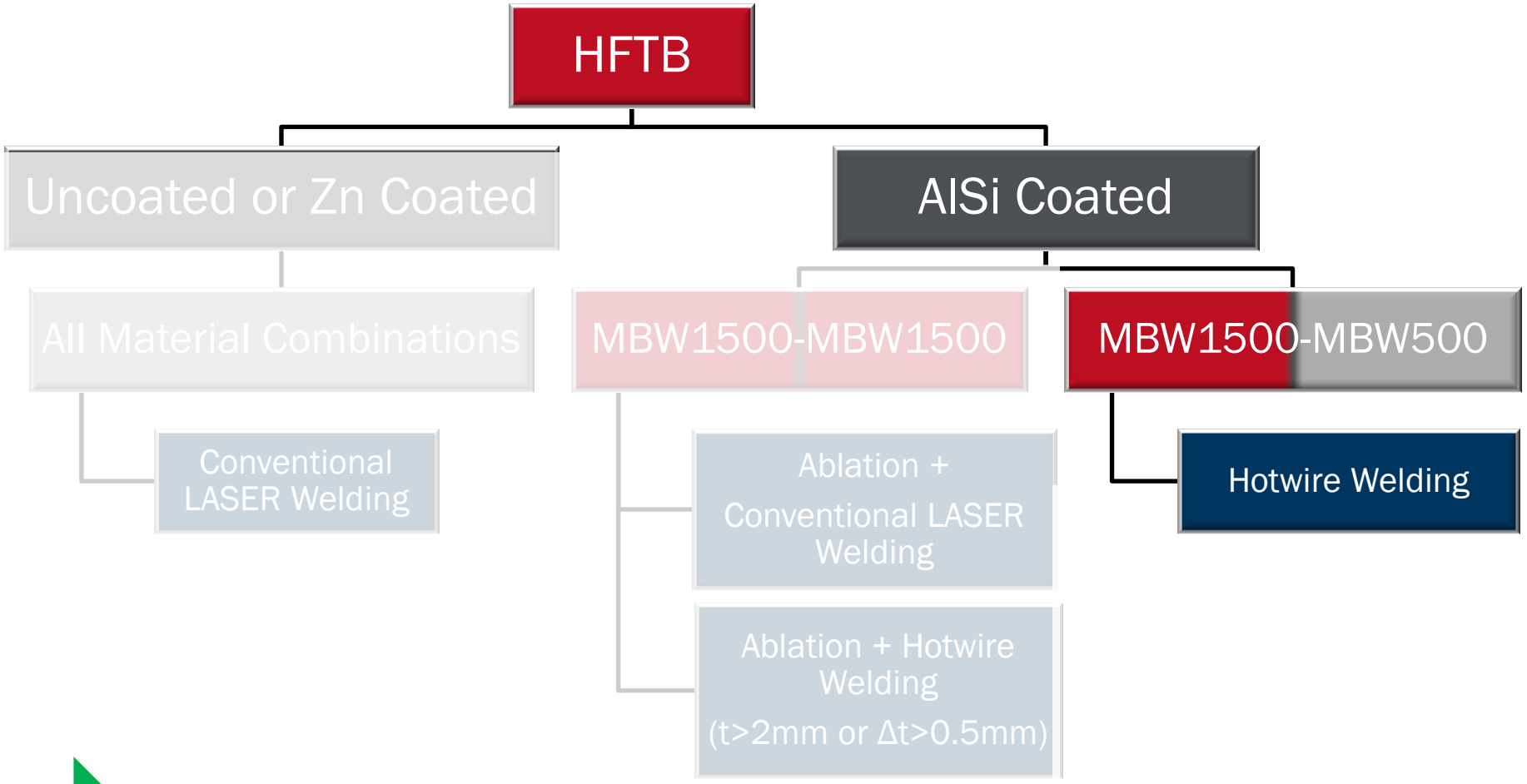


870 °C – 13s (Alloying)



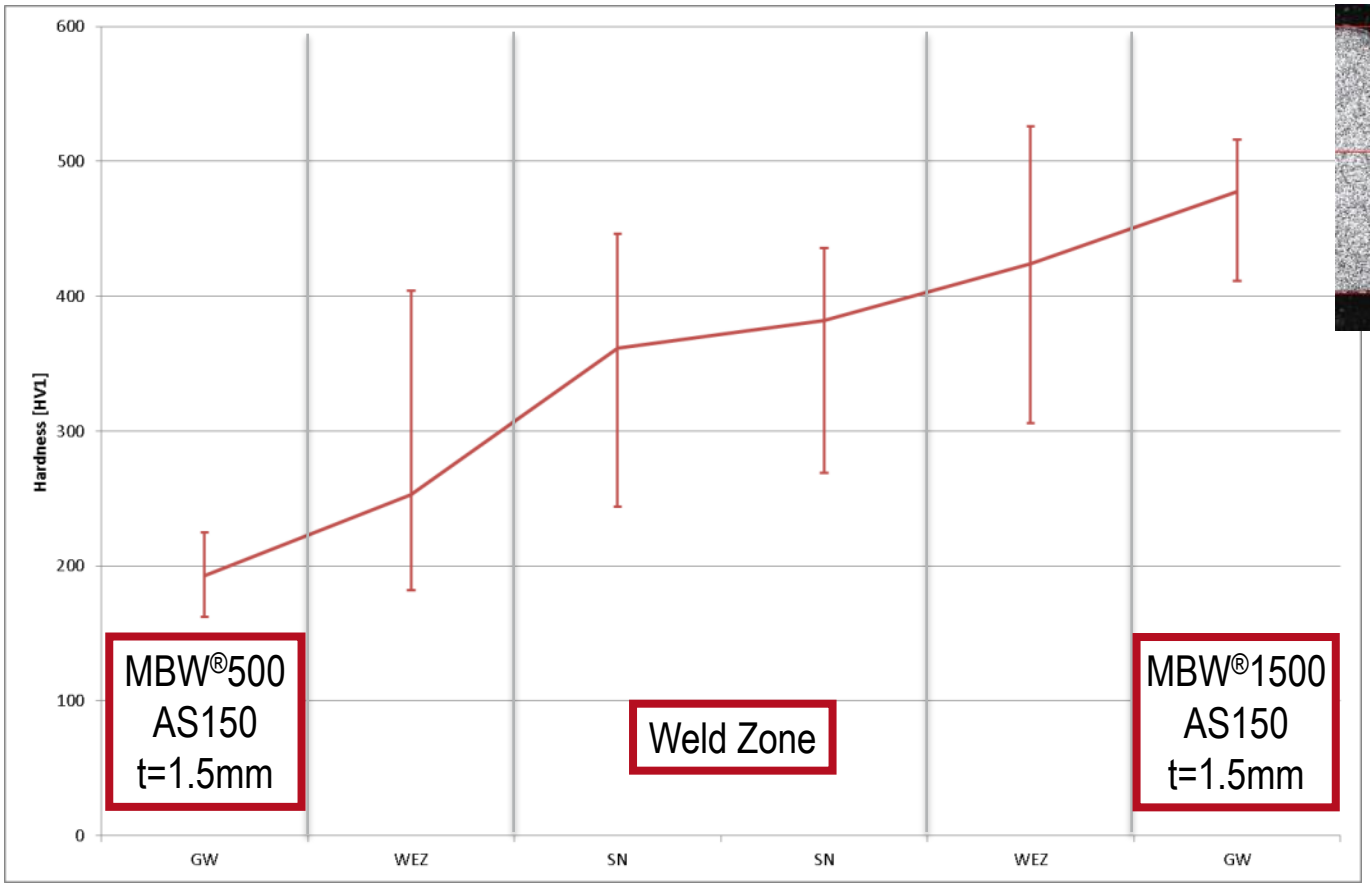
Improved hardness even with poor hot stamping conditions.

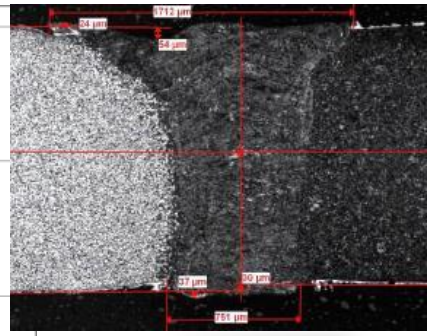
HFTB Overview



Hotwire welding can eliminate the ablation process for MBW1500-MBW500 combinations.

HFTB MBW1500/500 with Hotwire



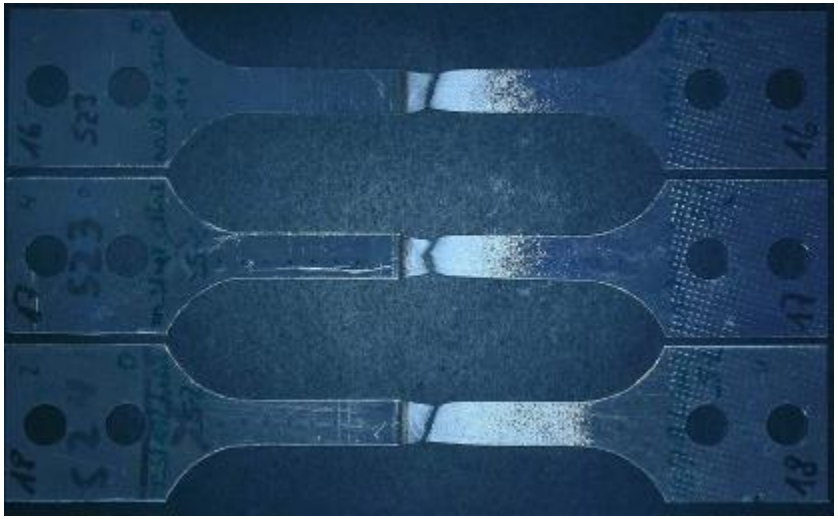


No hardness drop!
Hardness of weld always above hardness of micro-alloyed steel.

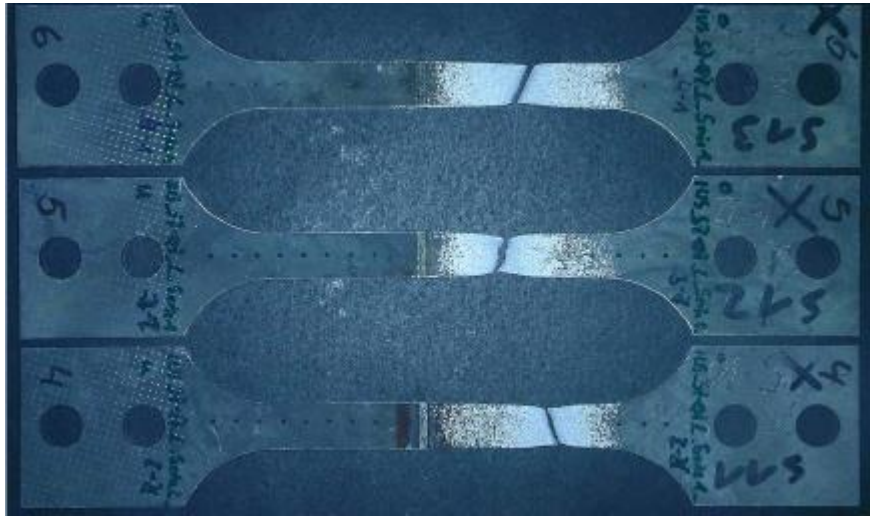
HFTB MBW1500/500 with Hotwire

High Strain Rate Tensile

Ablation Process - Reference



Hotwire Process

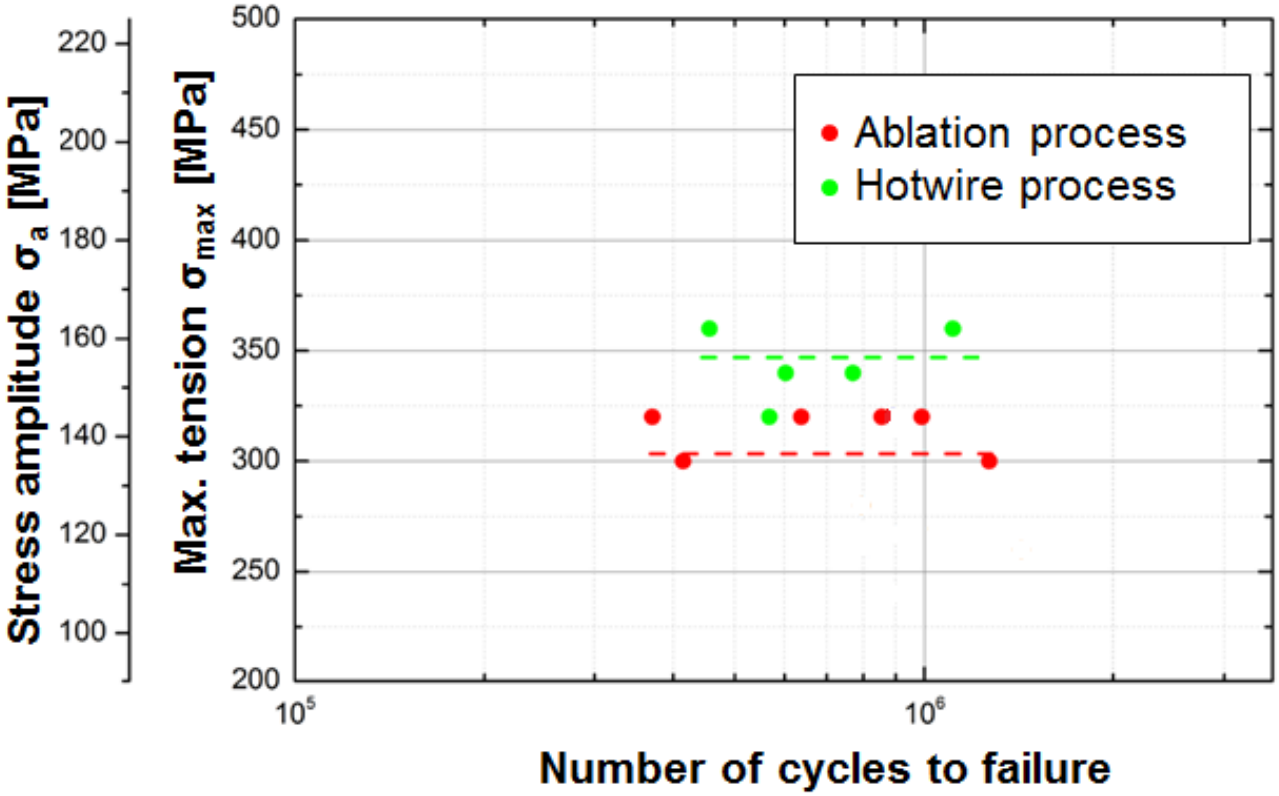


Tensile test at high strain rates
("Crash")
according to DIN EN ISO 26203-2

- 2.3 m/s ⇔ 40 s^{-1}
- 13.0 m/s ⇔ 200 s^{-1}

Fracture in tensile test always in micro-alloyed steel.

HFTB MBW1500/500 with Hotwire – Fatigue

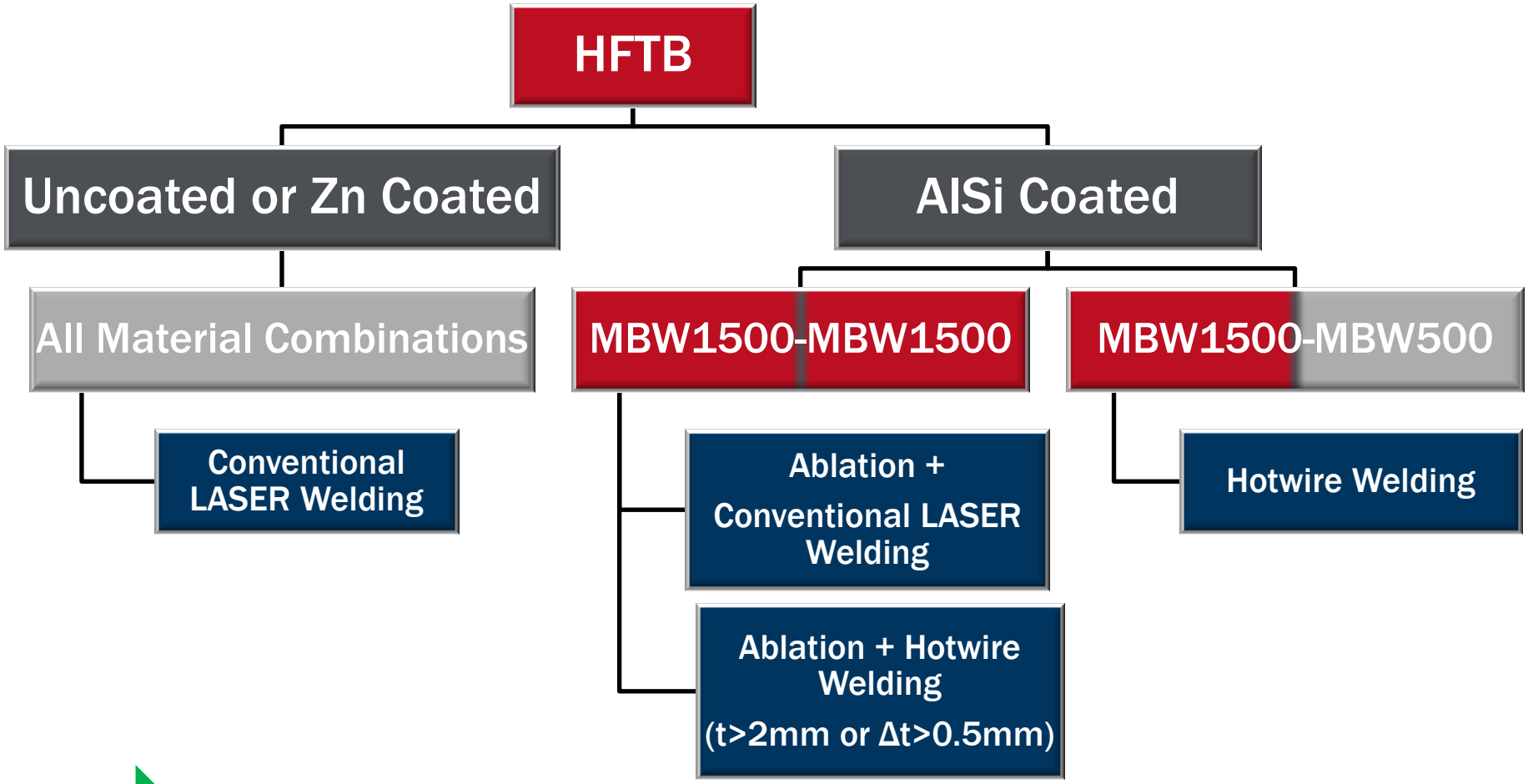


Test of cyclic load capacity

- Load ratio R = 0,1
- Frequency 90 Hz
- Limiting number of load cycles 2 x 10^6
- Start at σ_{max} = 200 MPa; increase of +20 MPa for not failed specimen

Samples from Hotwire process show better fatigue strength when compared to ablation process.

HFTB Overview



TWB / WISCO Tailored Blanks have the solutions for all your hotformed product requirements.

Future Trends

- Growing use of MBW1500-MBW500 tailored blanks for precise energy management
- Hot forming with mixed materials is a significant contribution to light weighting
- Hot wire process development underway for MBW1500-MBW1500

Questions?

A Worthington Steel and WISCO Tailored Blanks Joint Venture Company

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Inventing tomorrow – since 1985

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Thank You!

T&F Tools & Forming

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