



CBMM
Niobium N5



Metalsa

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Technology and Innovation Director

THE FUTURE IS ELECTRIC

Understand how Niobium Technologies help to make vehicles lighter and stronger, and more efficient and sustainable.

Meet Metalsa EV Strategy





60+

YEARS OF EXPERIENCE

Within the automotive industry, Metalsa has proven to be one of the best options in structural component solutions for light and heavy vehicles.



TIER 1 SUPPLIER FOR LIGHT AND
COMMERCIAL VEHICLES

ABOUT METALSA

We value our people not only for their experience, knowledge, and competencies, but also for their soft skills including their character, ethics, and integrity.



PRESENCE

Africa America Asia Europe



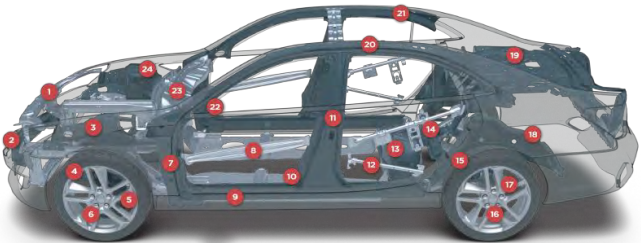
2017 SALES: US\$ 2.5 Billion



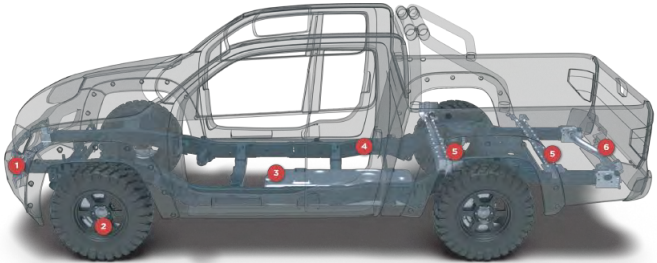
COLLEAGUES +13,500

PRODUCTS

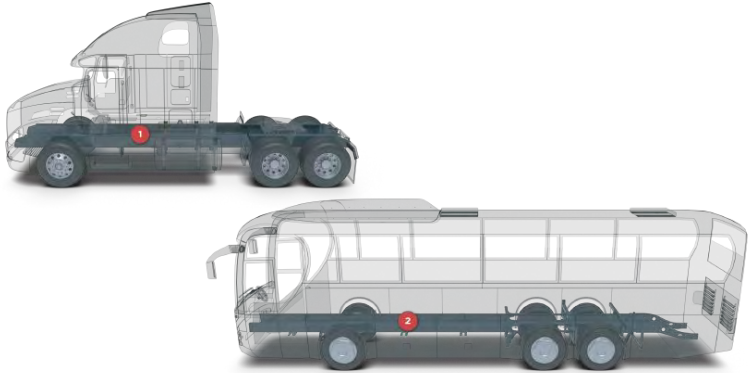
We develop Structural and Safety components that surpass All engineering performance requirements leveraging on advanced materials, lean and flexible processes, achieving successful program launches.



- 1. Front & Rear Bumpers
- 2. Front End Module
- 3. Front Axle Carrier/ Front Cradle
- 4. Front Side Rails
- 5. Front Lower Control Arm
- 6. Brake Dust Cover
- 7. A-Pillar
- 8. Front Door Side Impact Beam
- 9. Rocker / Sill Panel
- 10. Main Floor Panel
- 11. B-Pillar
- 12. Rear Door Beam
- 13. Fuel Tank
- 14. Upper Rear Door Beam
- 15. Rear Axle Carrier/Rear Cradle
- 16. Trailing Arm
- 17. Rear Upper Control Arm
- 18. Rear Wheel Housing
- 19. Rear Wall / Rear Floor Panel
- 20. Roof Bows
- 21. Rear Roof Rail
- 22. Front Roof Rail
- 23. Cowl Top and Braces
- 24. Front Wheel Housing



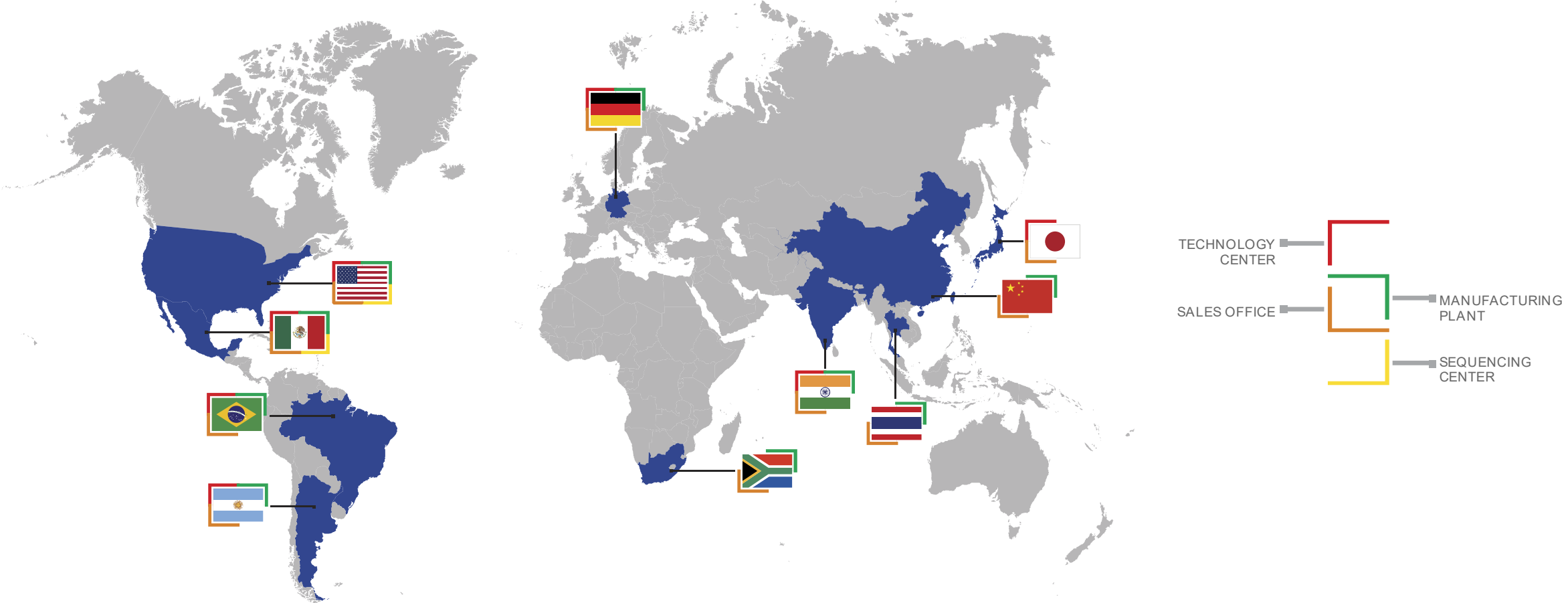
- 1. Front & Back Bumpers
- 2. Disc Cover
- 3. Chassis Frame
- 4. Fuel Tank
- 5. Truck Bow Cross Members
- 6. Trailer Hitch



- 1. Side Rails
- 2. Chassis Frame

WE OFFER GLOBAL TAILORED FRAME SOLUTIONS THAT OPTIMIZE WEIGHT AND DURABILITY THROUGH BALANCED AND SCALABLE MANUFACTURING PROCESSES FOR THE LOCAL NEEDS

GLOBAL PRESENCE



TRUSTED BY THE BEST.



INNOVATION IN METALSA

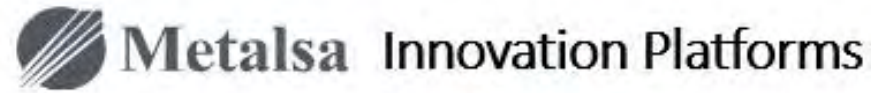


DISRUPTION AHEAD

Tech trends expect to bring more disruption to our industry in the next decade than it has since the car was invented.



TECHNOLOGY AND INNOVAITON










Innovation strategy founded upon

Advanced Research	Customer Needs	Mega Trends	Regulations
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- Materials
- Heat Treat
- Coatings
- Forming
- Assembly
- Industry 4.0
- Validation

-  Lightweight
-  Durability
-  Efficiency
-  Safety

-  Green
-  Efficient
-  Automated
-  Connected

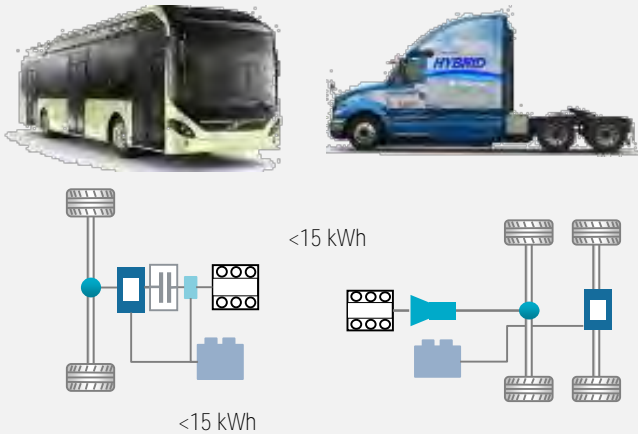
-  Reduced Emissions
-  Hours of Service
-  80,000 lbs. GVW

THE FUTURE IS ELECTRIC

What des have to change with the coming electric propulsion?

Hybrid Vehicles

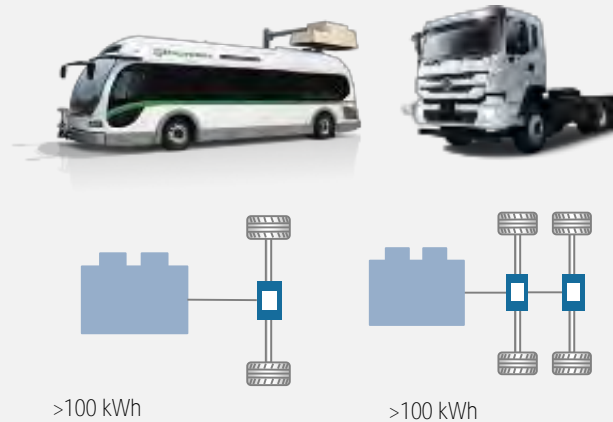
- M parallel model hybrid (mild hybrid)
- Need less batteries – Few weight added



- > No change in frame structure
- > Uses reduced battery packs and a small ICE

Full Electric with Battery

- Uses more batteries than hybrid (until 2.5 tons of batteries)
- Suitable for buses and trucks for deliverables and garbage collector



- > Demand chassis frame changes:
 - Weight reduction (mainly bus)
 - New dedicated architecture

Electric by Hydrogen (Fuel cell)

- Higher energy density
- Suitable for long haul trucks



- > Demand chassis frame changes:
 - Weight reduction
 - New dedicated architecture

Future commercial vehicles frame structures demands

Space for batteries

New mass distribution

Batteries protection and insulation

New vibration patterns

Weight reduction



New architectures

Balance of stiffness, mass and insulation

Use of multi-materials

ELECTRIC PICKUP TRUCK DEVELOPMENT

Electric Pickup Truck

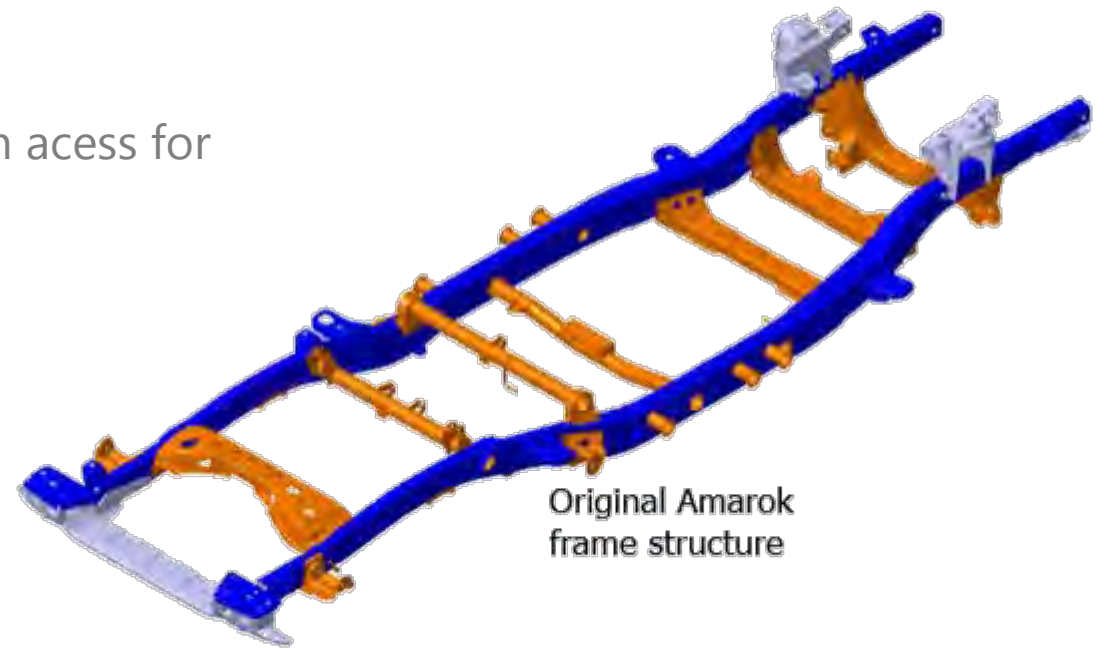


Applus⁺
IDIADA



Proposed Challenges

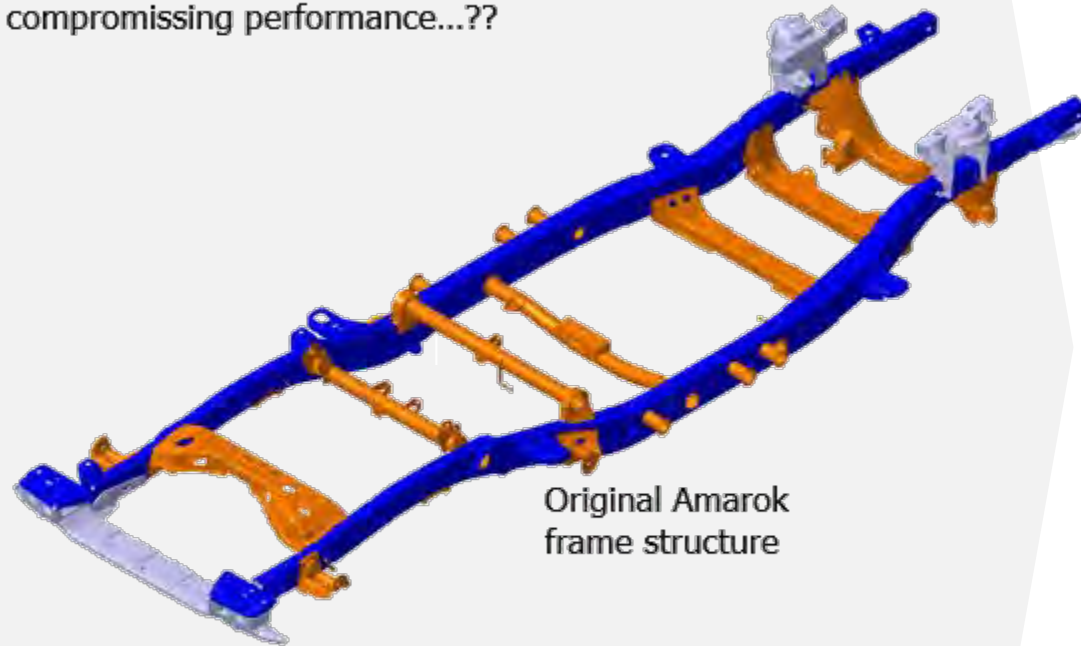
- > Adapt a electric power train with out body change
- > Keep vehicle dynamics and durability performance the same as original or better
- > Four wheel traction
- > Bateriaes well embeded and with aces for mantainance and replacement



Original Amarok
frame structure

New Concept Design

How can we adapt a different drive train, brand new energy storage and keep same carry over systems without compromising performance...??

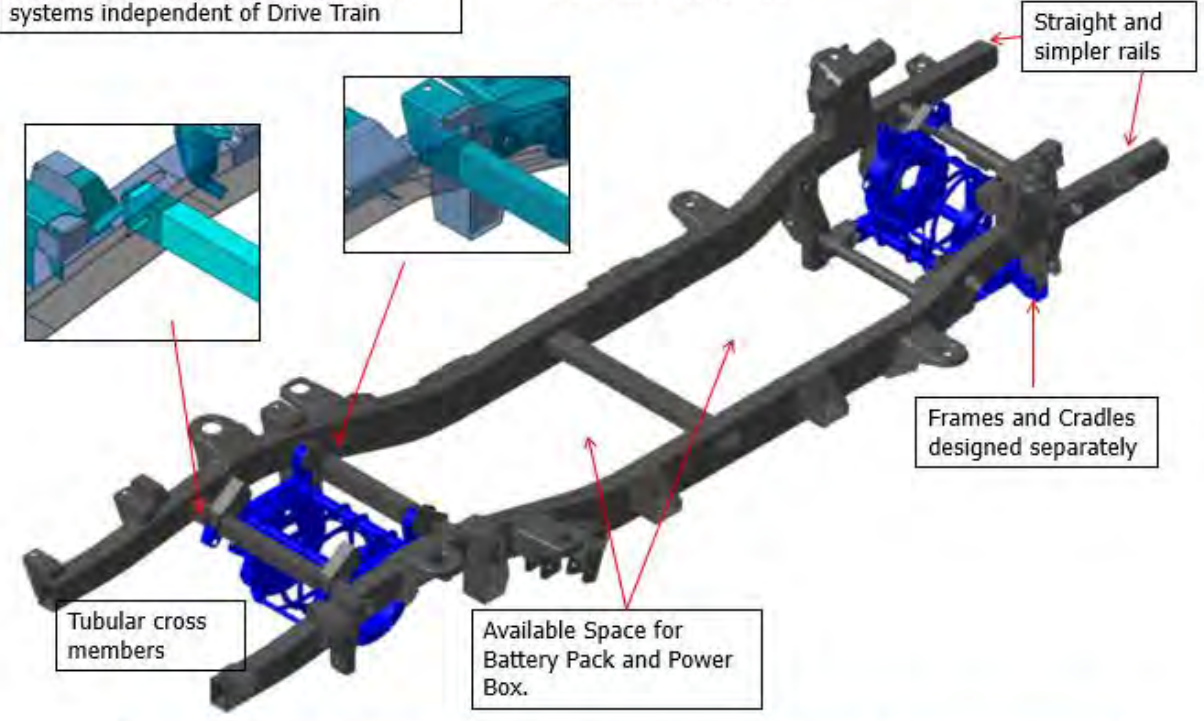


- Replaced
- Modified
- Keep

"SIMPLER AND STIFFER FRAME TO MEET TARGETS".

Frame allows carry over of major vehicle systems independent of Drive Train

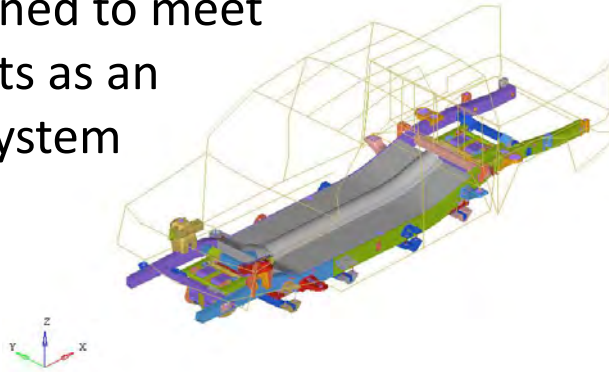
All AHSS material



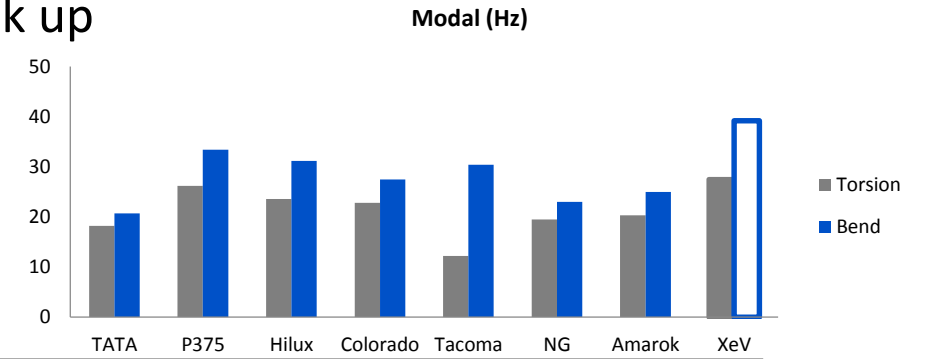
Frame architecture permits cradle modularity

Concept Validation

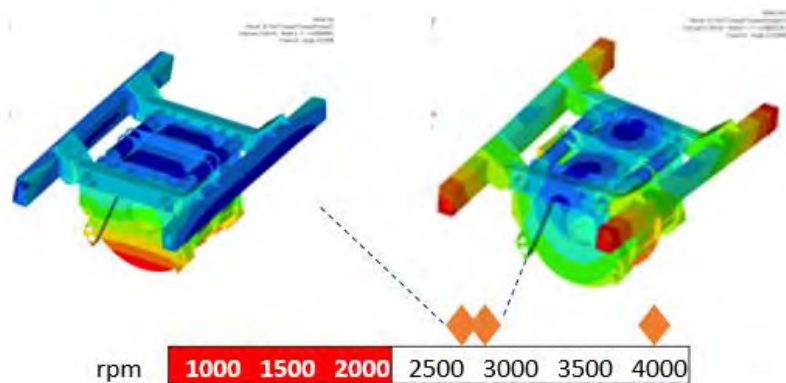
- Frame designed to meet modal targets as an integrated system



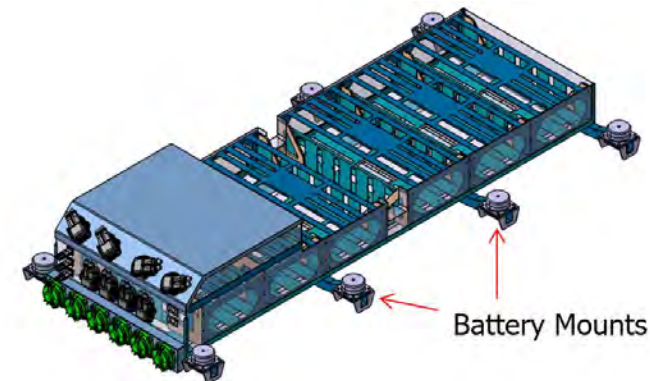
- Highest stiffness and simpler frame among benchmarked pick up truck frames



- Resonant frequencies of cradles are far from e-motor frequency band



- Battery mount bushing stiffness validated considering internal pack vibration modes



**BYD BRINGS INNOVATION TO
BRAZILIAN BUS MARKET**

BYD brings innovation to Brazilian bus market

INNOVATIONS

Electric buses
technology

Own batteries
technology

Light weight frame
structures using AHSS



Electric Bus Energy Efficiency and Savings

The use of light weight structure has a important hole in Electric Vehicle efficiency at this transition phase (from ICE to full electric)

TCO/Energy efficiency

	TCO	
	Diesel Bus	Electric Bus
Acquisition	\$ 131,429	\$ 285,714
Maintenance (\$/km)	\$ 0.09	\$ 0.06
Fuel (\$/km)	\$ 0.45	\$ 0.15
total (\$/km)	\$ 0.53	\$ 0.21
10years (731,000km)	\$ 519,908	\$ 439,806
Saving	\$	80,102



Weight reduction example

➔ For a WR of 517kg

8.38 kWh/day \$ 1.18 usd/day
 \$2,832.18 usd/10y
 517 kg
 \$ 5.48 usd/kg

➔ WR of 517kg allow to reduce 85 kg of batteries

Willing to pay 2018-2015

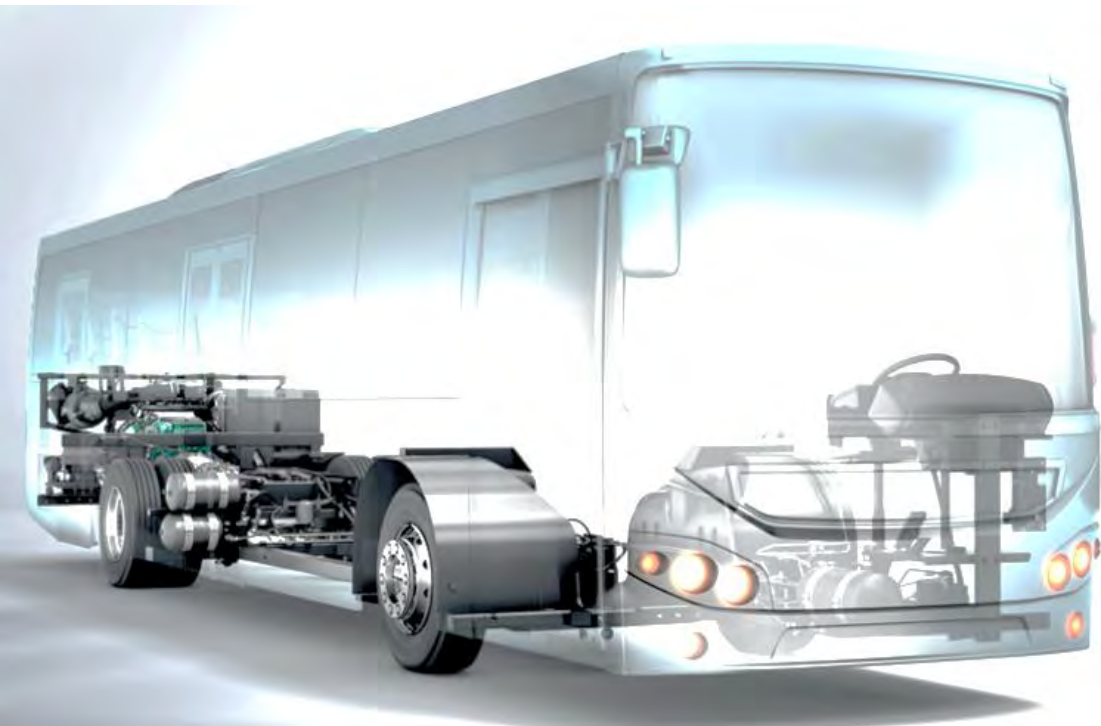
	2018	2020	2025
Cost =	\$ 225.00	\$ 210.00	\$ 180.00 usd/kWh
Total Cost =	\$40,320.00	\$37,632.00	\$32,256.00 usd
Saving =	\$ 2,016.00	\$ 1,881.60	\$ 1,612.80 usd
WTP =	\$ 1,612.80	\$ 1,505.28	\$ 1,290.24 usd
	\$ 4.22	\$ 3.94	\$ 3.38 usd/kg

A potential WTP around \$10usd/kg

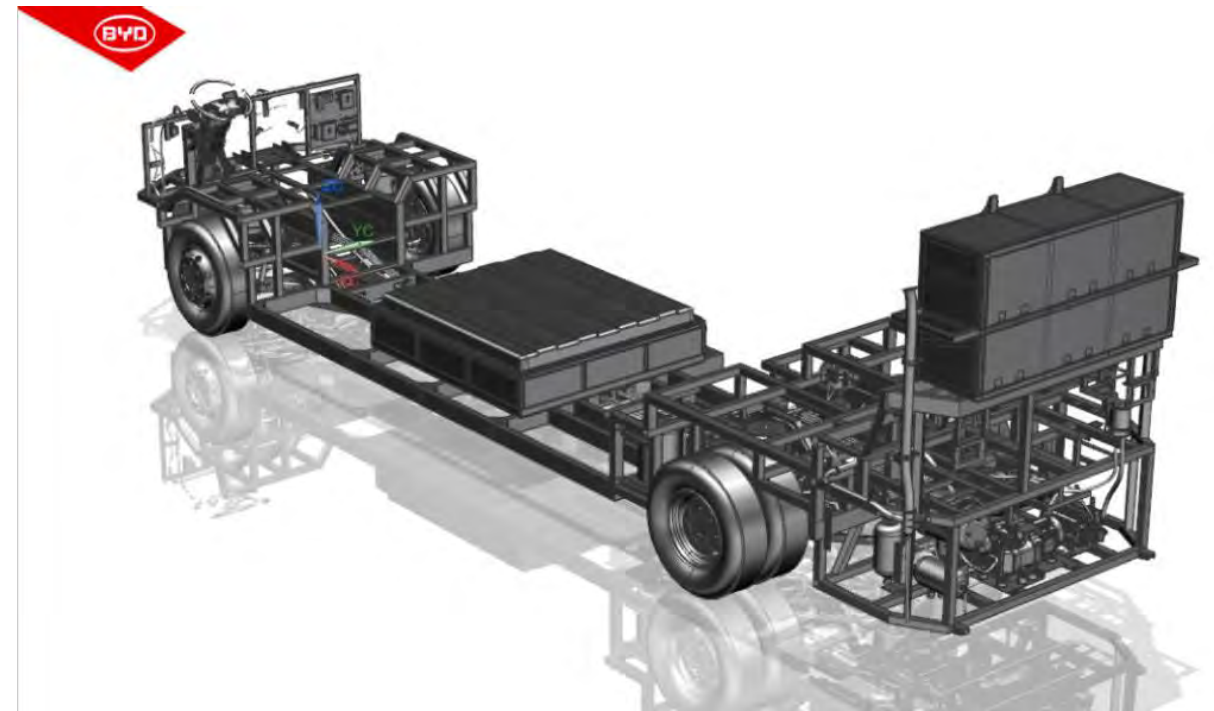
Low Floor Bus frame

The use of AHSS is possible reach until 25% of weight reduction in low floor bus frame structures, what is around 500kg

**Current bus chassis in Brazil
uses conventional HSS
(YS = 250 to 350 MPa)**



**New electric bus chassis using AHSS
(YS=700MPa) using Niobium**



Good Welding Performance

The use of HSLA Tubes, rolling technology with micro alloy strengthening technology based in Niobium give a very good weldability by reducing carbon equivalent and welding crack sensitive factor through low carbon low alloy design

C, %	Carbon equivalent (CE)
≤ 0.08	≤ 0.40






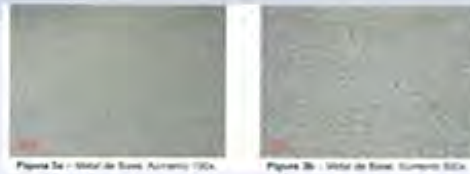
$$CE = C + \frac{Mn}{6} + \frac{Cu+Ni}{15} + \frac{Cr+Mo+V}{5}$$



Welding development

Metalsa has tested the AHSS steel using Niobium according several welding criteria

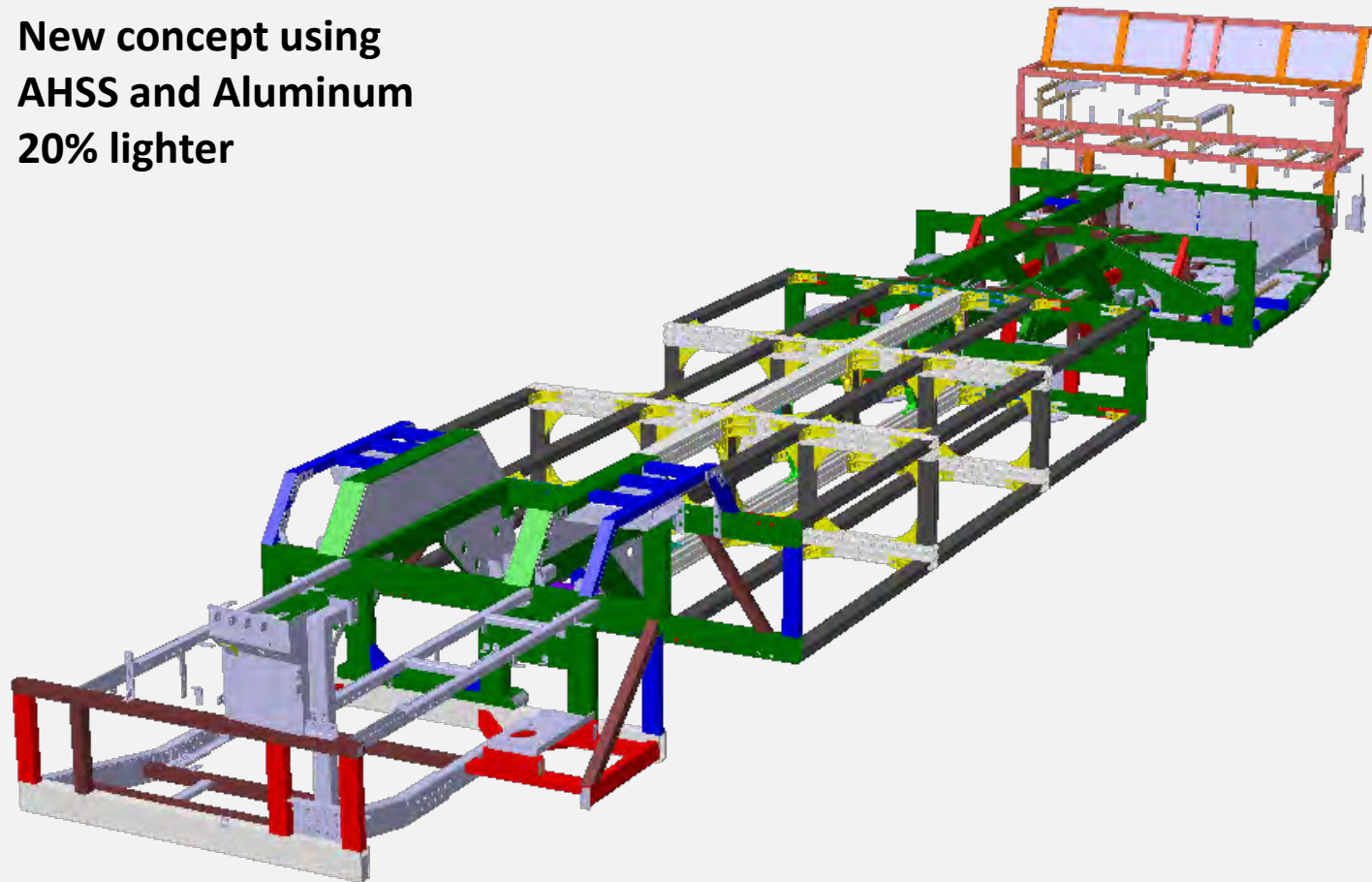
The material has approved in all of them

Test type	Illustrative example	Acceptation criteria
Visual aspect		No discontinuity No cracks No porosity
Traction		YS > min base material YS UTS > min base material UTS Ductile fracture
180° bending		No cracks No discontinuity
Hardness		$mHV_{weld} > mHV_{base\ material}$ $mHV_{weld} > mHV_{HAZ}$ $mHV_{HAZ} > 0.9 \times mHV_{base\ material}$
Macrograph		Good penetration Convexity No cracks No porosity
Micrograph		Predominantly ferrite and pearlite Absence of carbides and hydrides No inclusions

Metalsa Value Proposition for high floor electric buses

- Design optimization
- Reduce components
- Increase flexibility
- Reduce weight
- Reduce lead-time of assembly
- Reduce need for investment

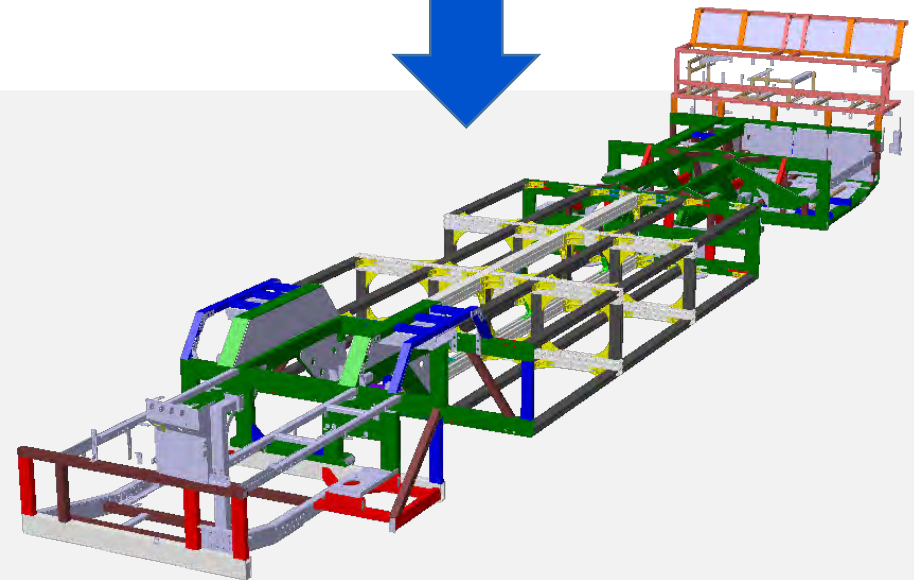
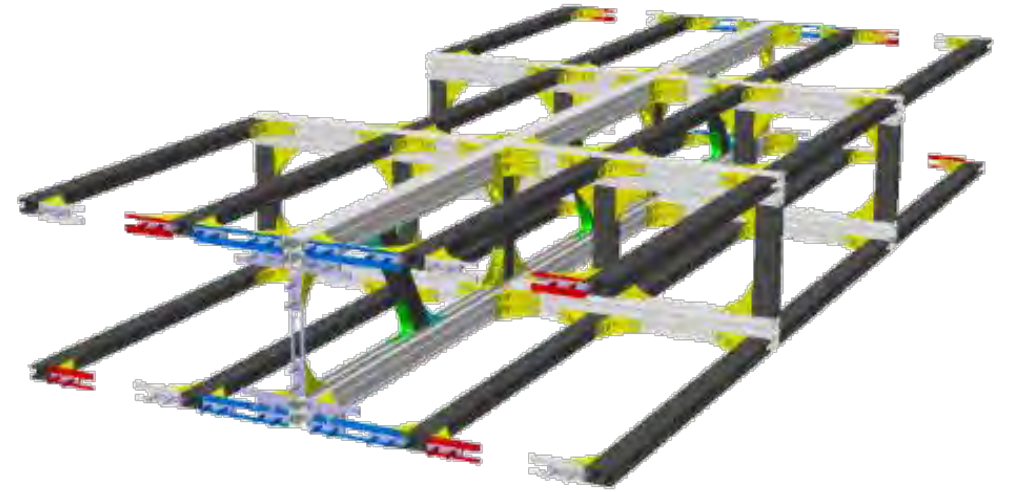
**New concept using
AHSS and Aluminum
20% lighter**



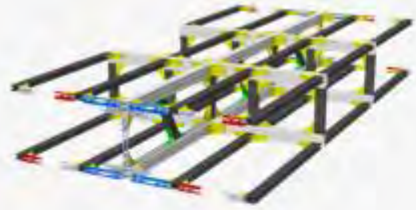
Simply and lighter frame

Complete list of benefits:

- 20% WR
- 50% less welding
- 42% less painting area
- Wide space for batteries
- Reduce lead time of fabrication in 30%
- Reduce manufacturing area in 50%



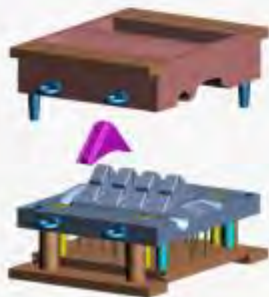
New Solution using Aluminum extruded and casting parts



ALUMINUM STRUCTURE



**CRITICAL STRUCTURAL
PART FOR JOINT**



CASTING PROCESS

NIOBIUM IMPROVING ALUMINUM CASTING PROCESS

Needs for improvement in Aluminum casting alloys

ALUMINUM ALLOYS



PROPERTIES

- LOW DENSITY, 2.7 g/cc
- GOOD MECHANICAL PROPERTIES
- HIGH CORROSION RESISTANCE
- HIGH THERMAL CONDUCTIVITY
- LOW ELECTRICAL RESISTIVITY

ALLOYS

WROUGHT

CAST (Al-Si)

GRAIN

REFINEMENT

IMPROVEMENT

FLUIDITY/CASTABILITY

MACHINABILITY

CHEMICAL HOMOGENEITY

MECHANICAL PROPERTIES

SURFACE QUALITY

REDUCED SHRINKAGE POROSITY

- **Silicon is very important for casting process because:**

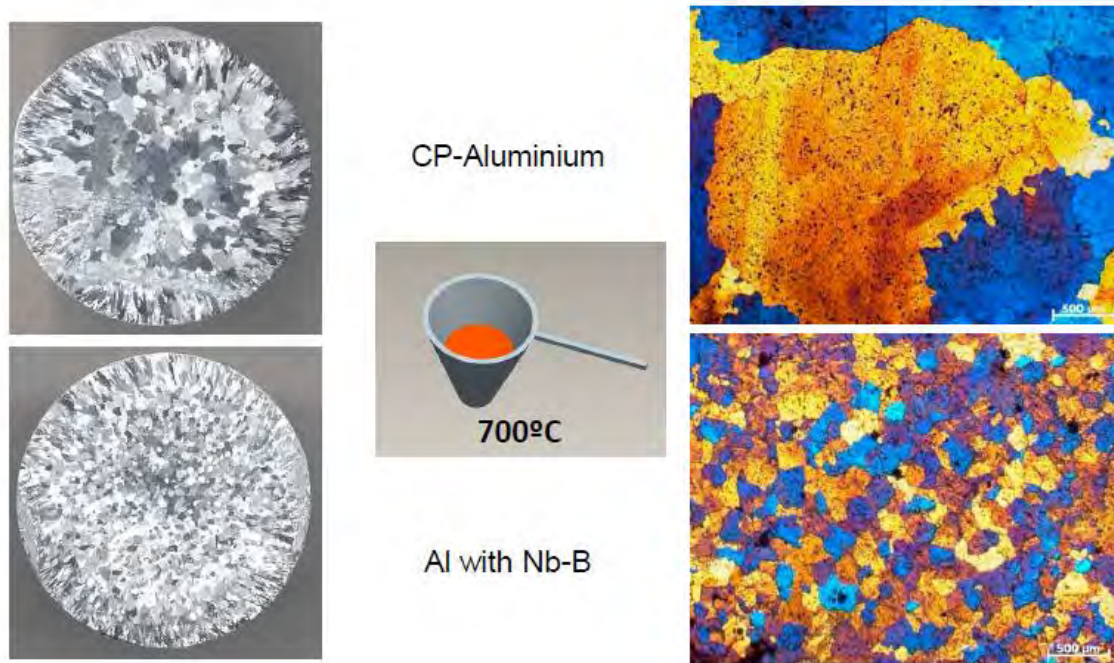
- ✓ increases the fluidity of the liquid aluminum allowing it to flow better through the casting mold cavities,
- ✓ allowing products of more complex shapes to be obtained.
- ✓ It also reduces shrinkage during cooling,
- ✓ reduces porosity in castings,
- ✓ reduces coefficient of thermal expansion,
- ✓ and improves weldability.

- **Conventional additives for grain size refinement lose efficiency for Si >6%**

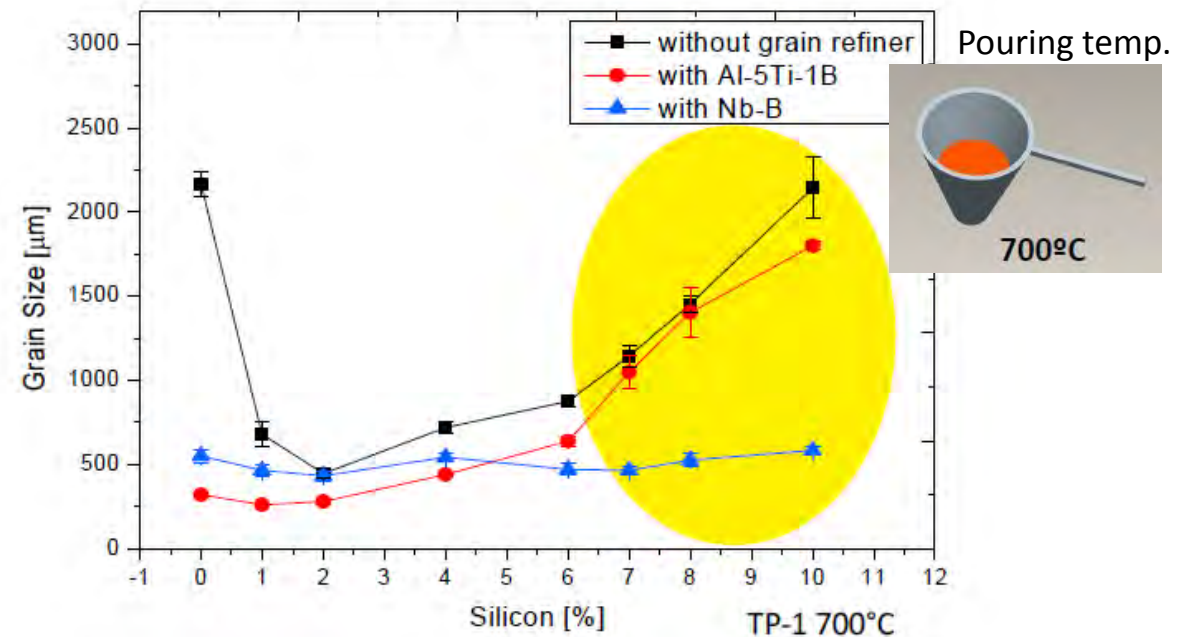
- **Niobium can solve this problem!**

Critical casting joint part got performance improvement using Niobium

Niobium effect of grain size refinement



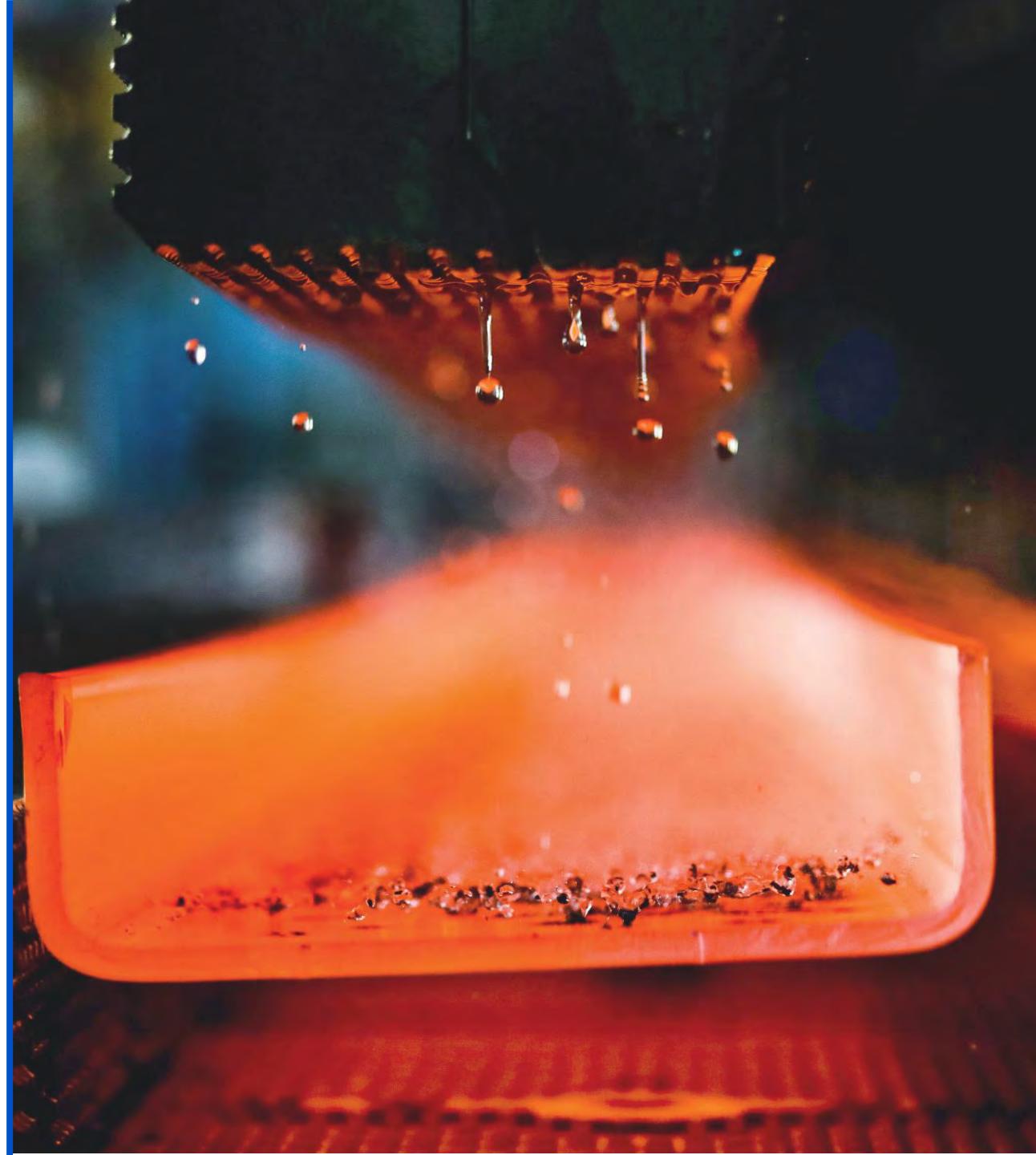
Comparison of AL-Ti and Nb-B Hypoeutectic Binary Ai-Si Alloys



Source: Doctor of Philosophy (PhD) thesis
by Magdalena Nowak
Brunel Centre for Advanced Solidification Technology (BCAST)
September 2011

SUMMARY

- Nb-B addition to Al-Si melt refines the grain structure of casting
- End user benefits:
 - Improved strength & ductility
Lighter/Thinner structures
 - Homogeneous properties (thick & thin sections)
Complex structures
 - Tolerant to Fe contamination
Closed loop recycling of scrap containing higher Fe
 - Reduced shrinkage porosity – improved soundness
Component rejection ratio can be minimized



CONCLUSIONS

- In the Electric Pickup Project the use of advanced high strength steel (AHSS) using Niobium was fundamental to reach the new frame architecture using just four crossmembers
- The BYD Electric bus has introduced in Brazilian market a new frame design using AHSS using Niobium, presenting a light weight structure with very good weldability performance and more energy efficiency
- Metalsa has presented a value proposition introducing aluminum parts in the frame. The use of Niobium in the Al-Si alloys could improve strength & ductility of casting parts, among other benefits





COMMENTS/
QUESTIONS?

THANK YOU

