



Aluminiums role in lightweighting and fuel efficiency in trucks and trailers

46%

Oxygen

28%

Silicon

8%

Aluminium

5%

Iron

4%

Calcium

3%

Sodium

3%

Potassium

2%

Magnesium

0.6%

Titanium

0.1%

Hydrogen

0.1%

Phosphor

0.009%

Carbon

0.009%

Manganese



Aluminium is the metal for the future

Properties lead to increased market share

✓ Lightweight



1/3 density of steel means lighter vehicles, lower energy consumption and reduced emissions

✓ Recyclability



5% of original energy consumption
75% of all aluminium produced still in use

✓ Formability



Makes it possible to integrate different technologies into one solution, e.g. in buildings

✓ Conductivity



A superconductor for heat and electricity, more cost efficient than copper, enabling energy-efficient systems for electrical transmission, such as transfer components

✓ Corrosion resistant



Natural oxide layer protects the metal against corrosion and makes it virtually maintenance free

✓ Alloying technology



Aluminium can be made hard, soft, stiff, bendable, smooth, temperature resistant etc. depending on the actual need, by developing tailor-made alloys

Some data of common materials

		Al	Fe	Cu	Mg	PA6	PTFE
Density	kg/dm ³	2,7	7,9	8,9	1,7	1,2	2,2
Melting point	°C	658	1540	1083	650	225	325
Heat conductivity	W/m°C	225	75	390	155	0,23	0,25
Heat capacity	J/kg°C	900	450	390	1050	1680	1000
Resistivity	nΩm	30	105	17	44		
Heat expansion coefficient	x10 ⁶ /°C	24	12	6	26	8	100
Modulus of elasticity	GPa	70	220	120	44	8	

The values are for pure metals
 PA6 = polyamide (nylon)
 PTFE = fluoropolymer/thermoplastic (teflon)

Does not spark when frictioned



Aluminium does not produce sparks, an important characteristic when transporting flammable or explosive substances.

Non-sparking eliminates the risk of fires and explosions in cases of accidents, increasing safety.

Lightness

1 kg de Steel



1/2 kg de Aluminium



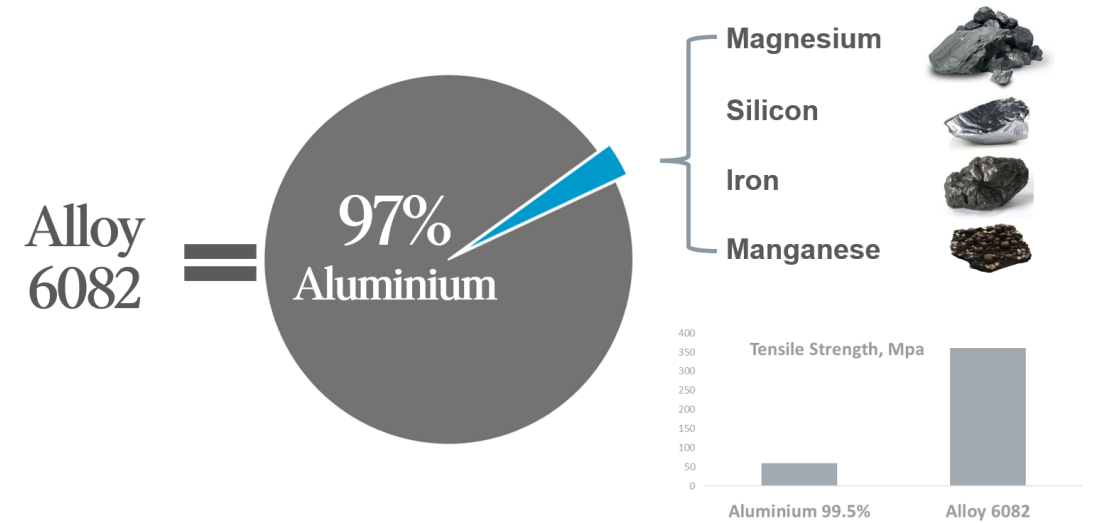
- Greater payload
- Faster return on any additional investment
- Operating cost reduction
- Greater load capacity of the implement
- Possible reduction in the required fleet

Mechanical resistance

Wide range of mechanical properties



Alloy - The addition of small amounts of other elements that affect properties of the aluminium



Corrosion resistance

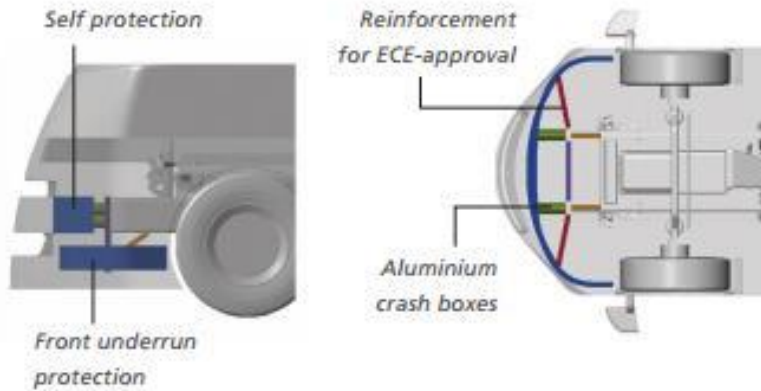


- Thin film that insulates and protects aluminium
- Surface treatments (anodizing) improve natural corrosion resistance

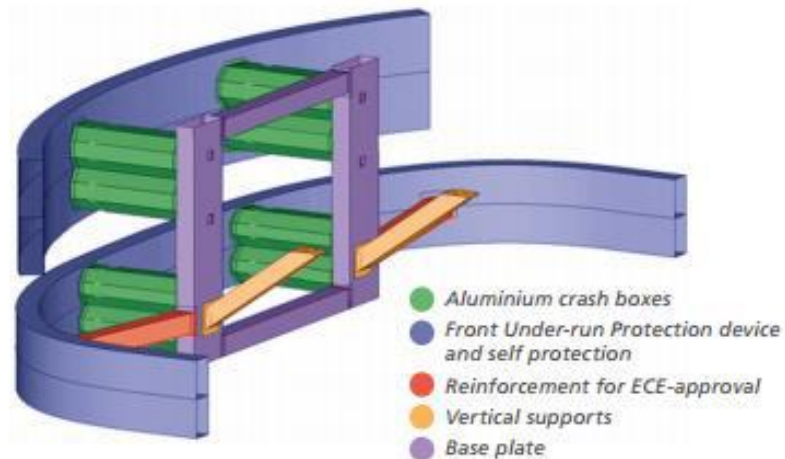


- ✓ **Reduce maintenance and maintenance costs**
- ✓ **Extend useful life**

Security



- Lighter vehicles
 - ✓ Easier to drive
 - ✓ Shorter braking distances
- In the event of a shock, aluminium deforms and absorbs a significant amount of energy (twice as much as steel)



Recycling

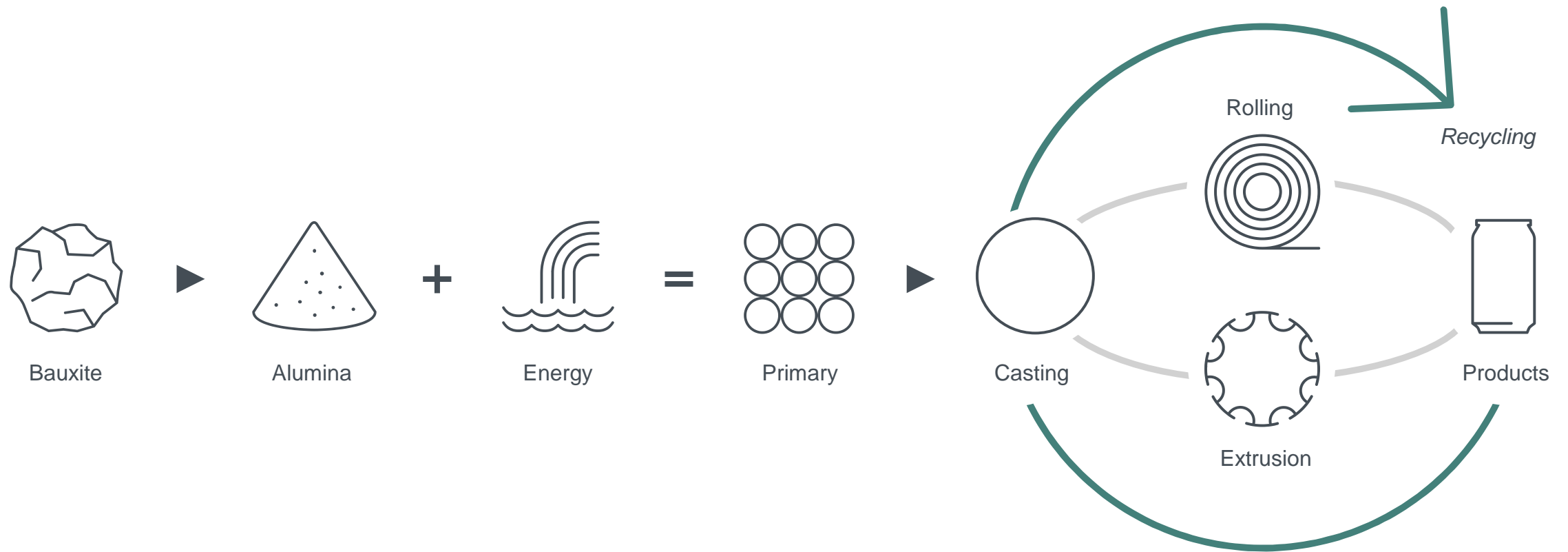


- Sales value of scrap*
- Aluminium – USD 2.00 / kg
- Steel – USD 0.02 / kg
- Wood – cost for disposal (!?)

*Note: Estimated average values, for reference

Aluminium can be recycled over and over again with reduced energy input

(Only 5% energy needed)





WEIGHT REDUCTION
(1 ton)



CONSUMPTION REDUCTION
(11300 l Fuel)



EMISSIONS REDUCTION
(37 t of CO₂ emitted)

Is the Aluminium weak?



Break of paradigms

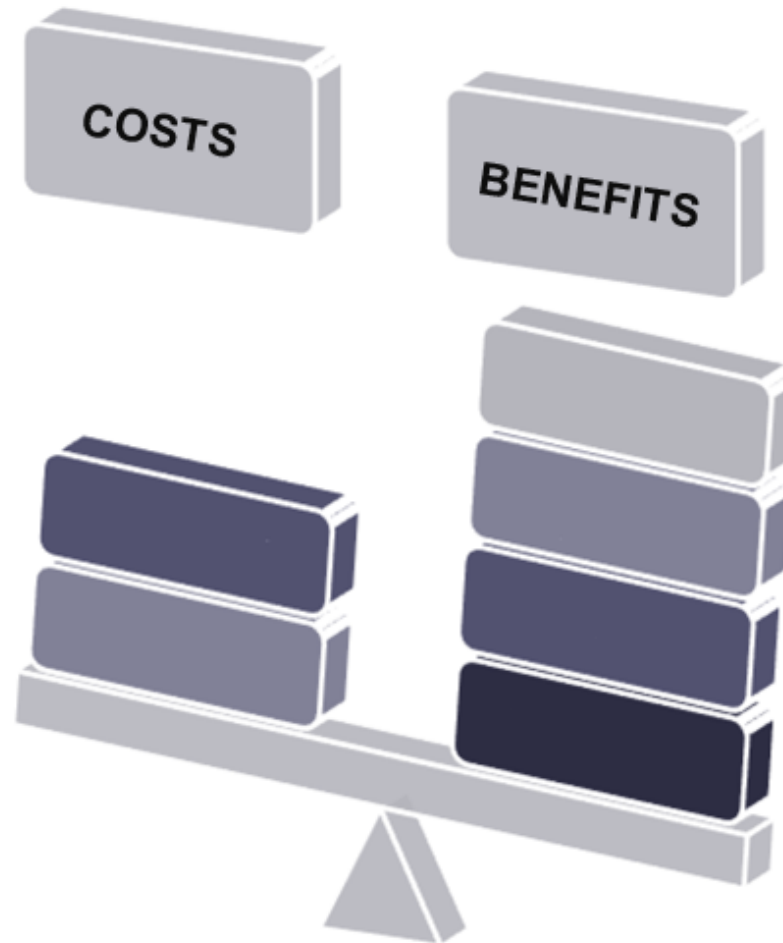


Is the Aluminium expensive?



Break of paradigms

Very important analysis: Costs x Benefits

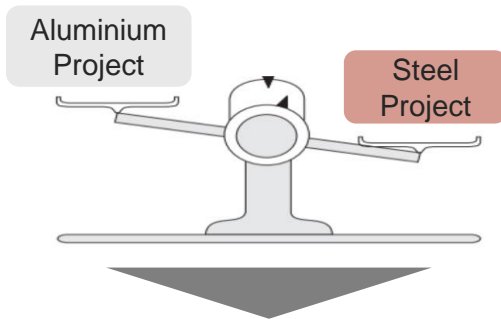




Aluminium is the right choice

Lightweight

- Aluminum is 66% lighter than Steel
- Potential of 40% to 50% weight reduction
- comparing with steel (project)
- Allow infinitely type of design



- Higher net load capacity
- Less fleet of trucks
- Cost reduction with maintenance and fuel
- Increase trailer die lifetime

Safety

- No spark
- Better drivability
- Shorter breaking distance needed



Green

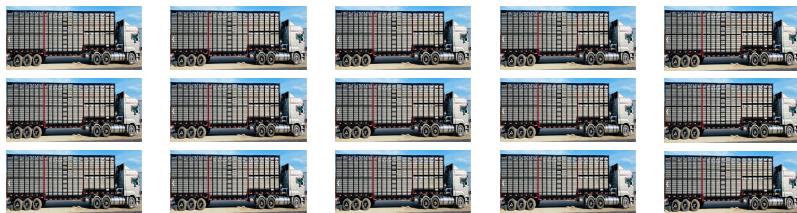
- Infinitely Recyclable
- Less CO2 emission for the vehicle



Steel vs Aluminum – Cow transportation



Steel



Aluminum



Larger cargo

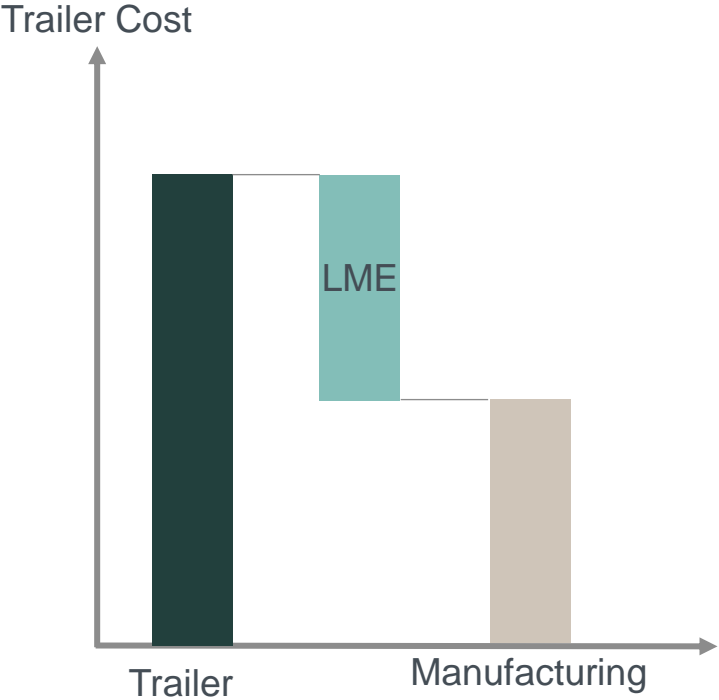
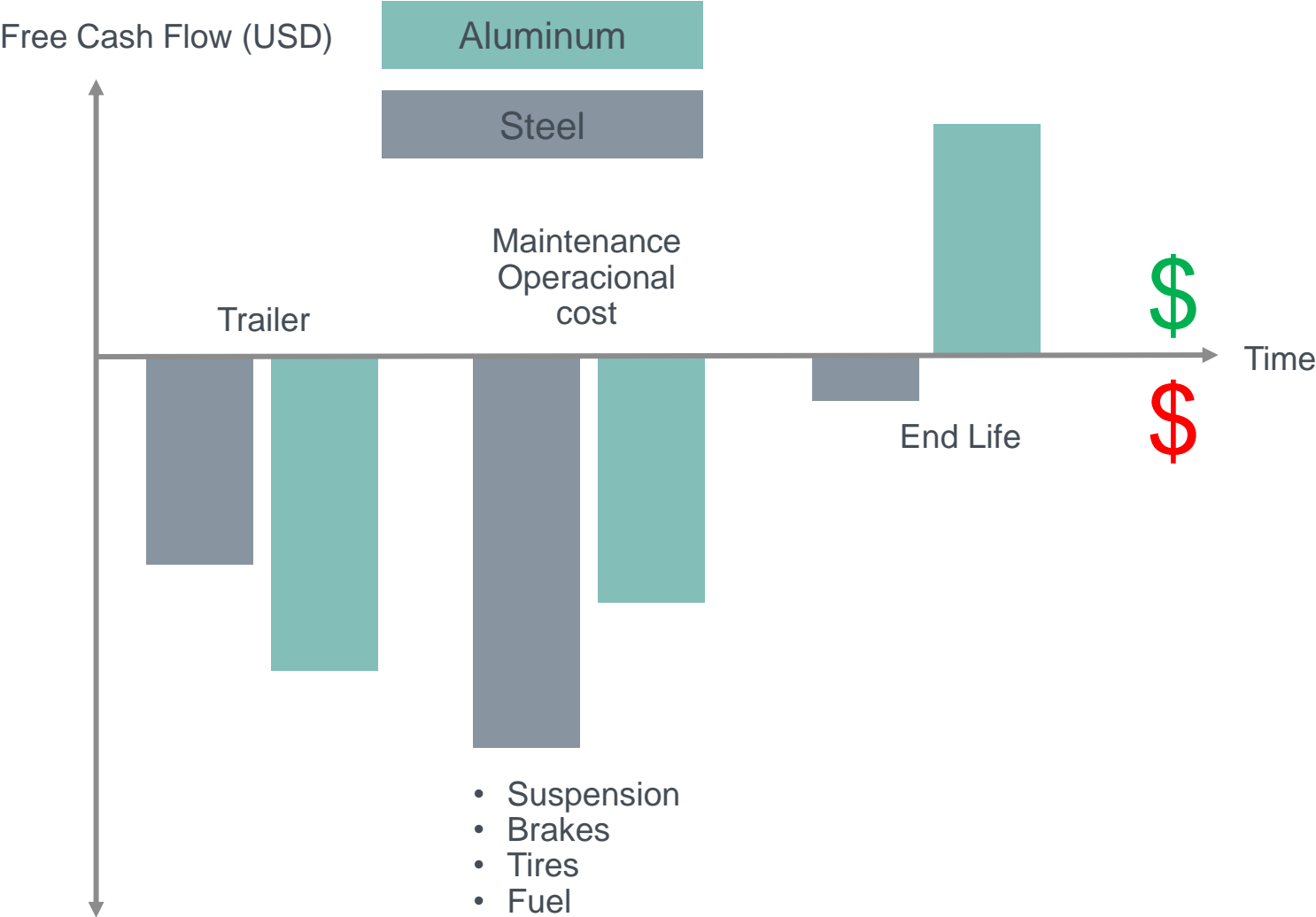
15% less fuel consumption (empty)

Saving 15K USD per year

6 ton of weight reduction

Reduce freight quantity in 20%

Residual Value



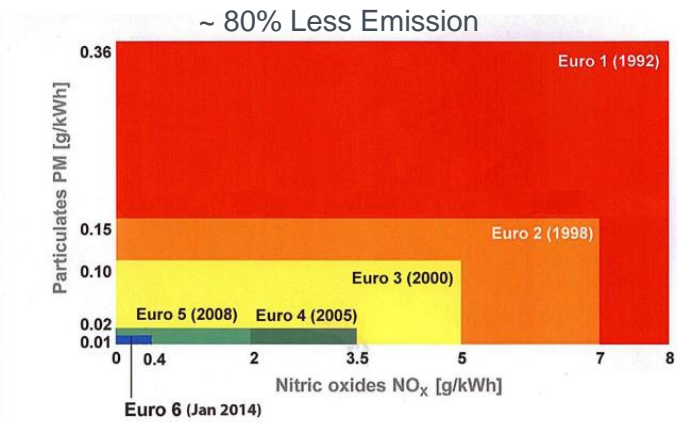


Innovation in Aluminium manufacturing for trucks and trailers

Market trends lead to increase of aluminium content



EURO 6 STANDARD

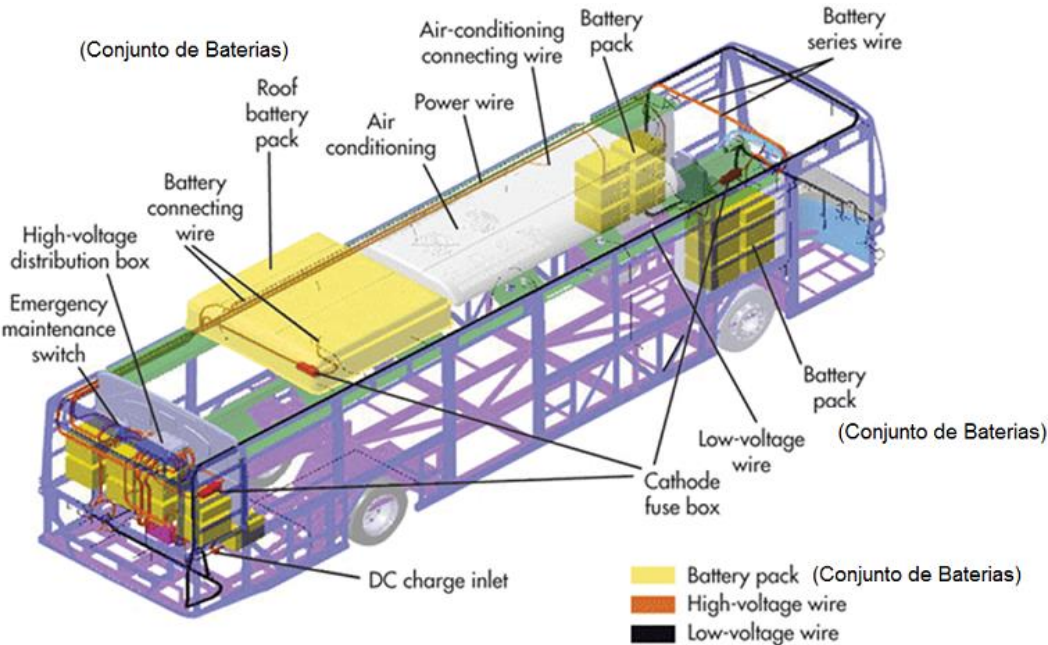


2023 – Implementation in Brazil and Argentina

Group	Region	2014	2015	2016	2017	2018	2019	2020	2021	2022
Other selected markets	US & Canada	US 2010								
	EU	Euro VI								
	Japan	PNLTES								
	South Korea	Euro V	Euro VI							
	Turkey	Euro V	Euro VI							
	China	China IV			China V			China VI (proposed)		
Latin America	India	Bharat III			Bharat IV			Bharat VI		
	Mexico	US 2004/Euro IV						US 2010/Euro VI (proposed)		
	Chile	Euro IV			Euro VI (buses in Santiago)					
	Brazil	P-7								
	Argentina	Euro IV		Euro V						
	Colombia	Euro II	Euro IV							



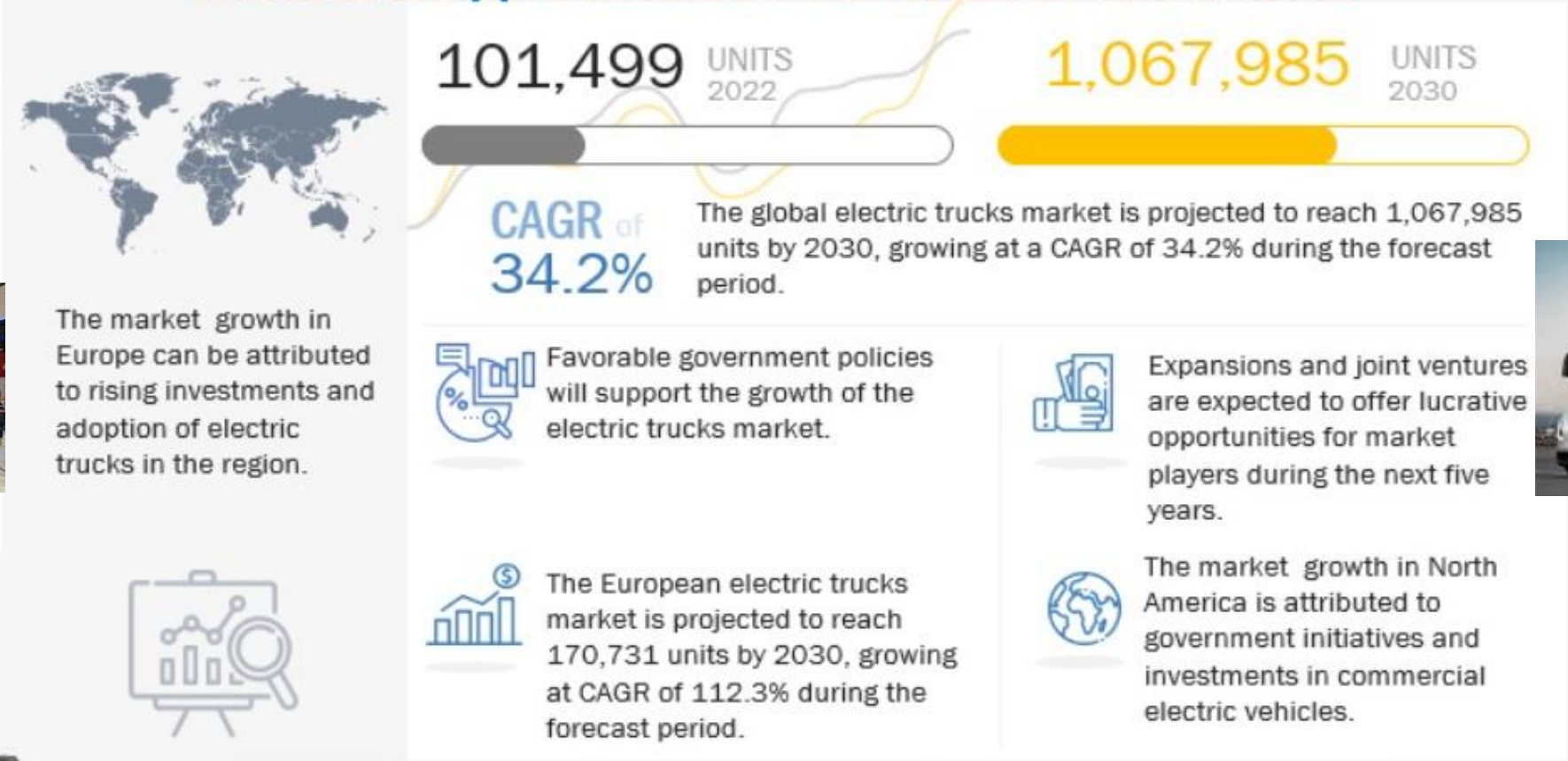
EV VEHICLES



EV's truck is a reality



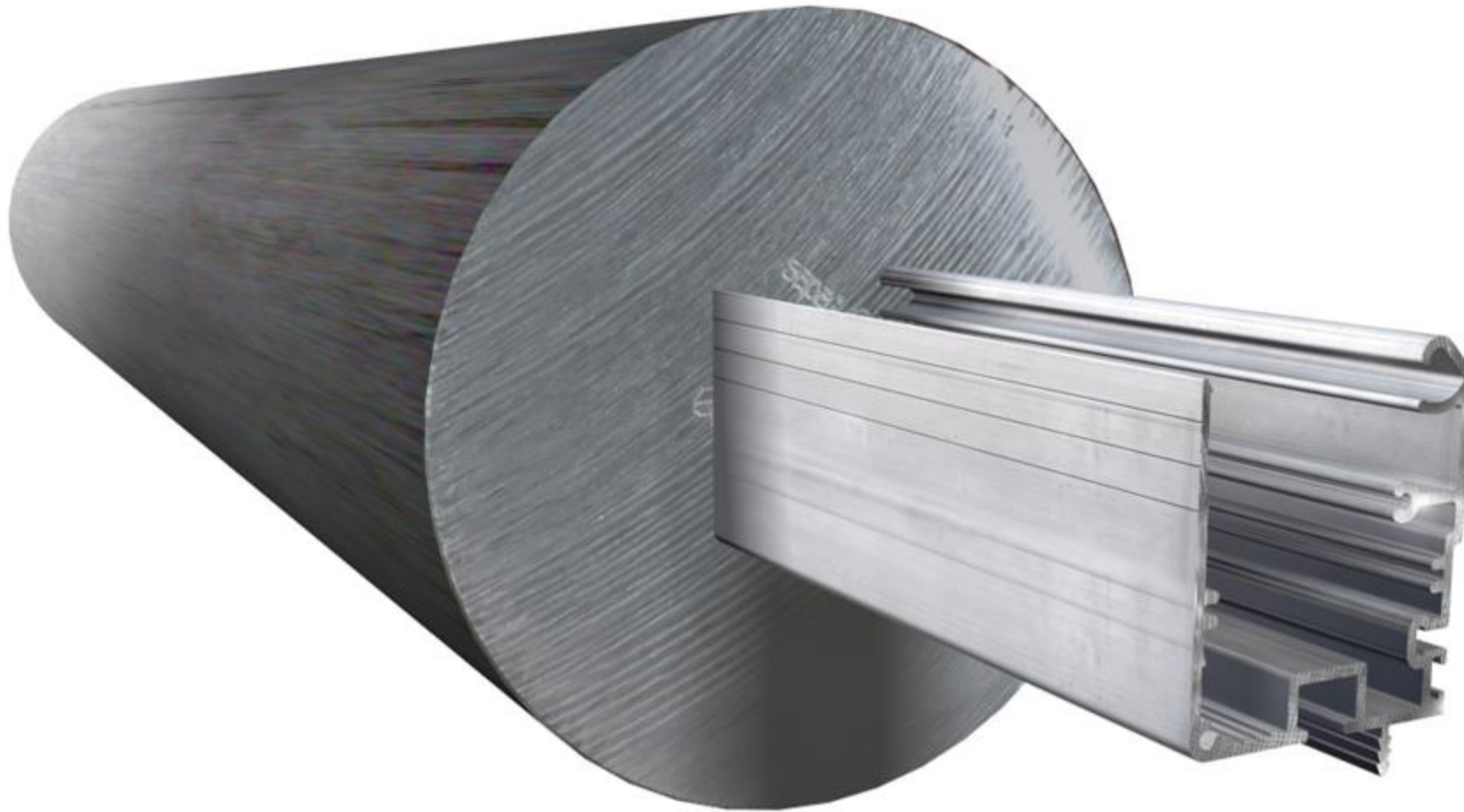
Attractive Opportunities in the Electric Truck Market



Source: Industry Journals, Interviews with Experts, and MarketsandMarkets Analysis

Extrusion

Extrusion Process

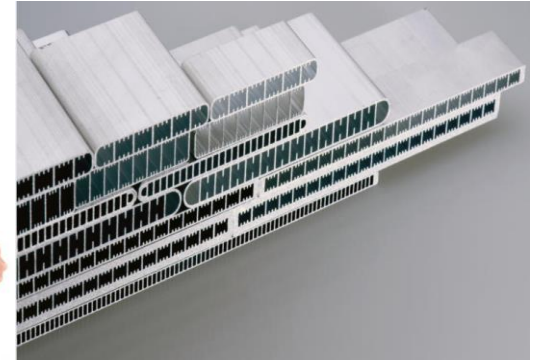
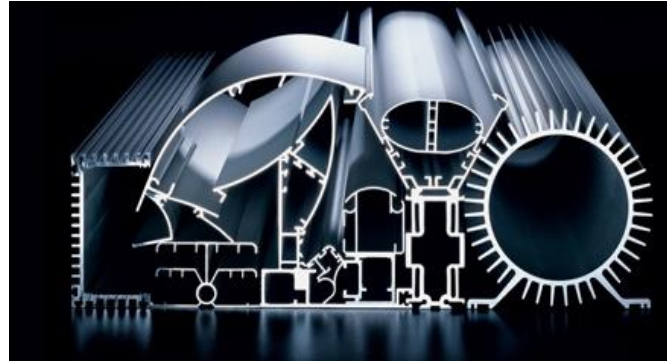


Versatility

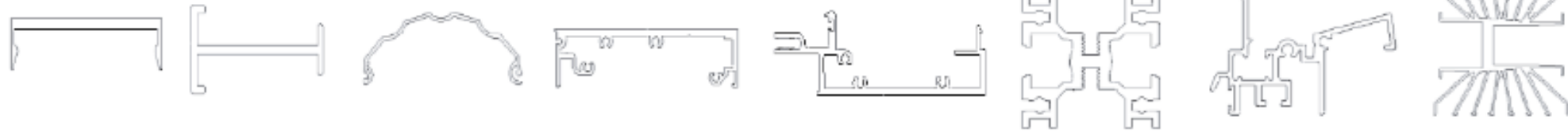
One of the **great advantages** of the aluminium **extrusion process** is the possibility of manufacturing **thousands of geometries**.



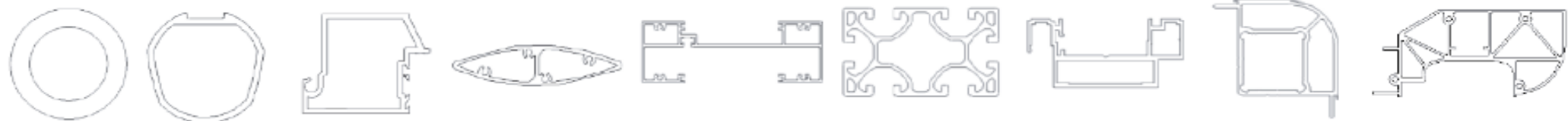
Aluminium extrusions can have very complex cross sections



Solid extrusions



Hollow extrusions



simple → complex

Aluminium Alloys

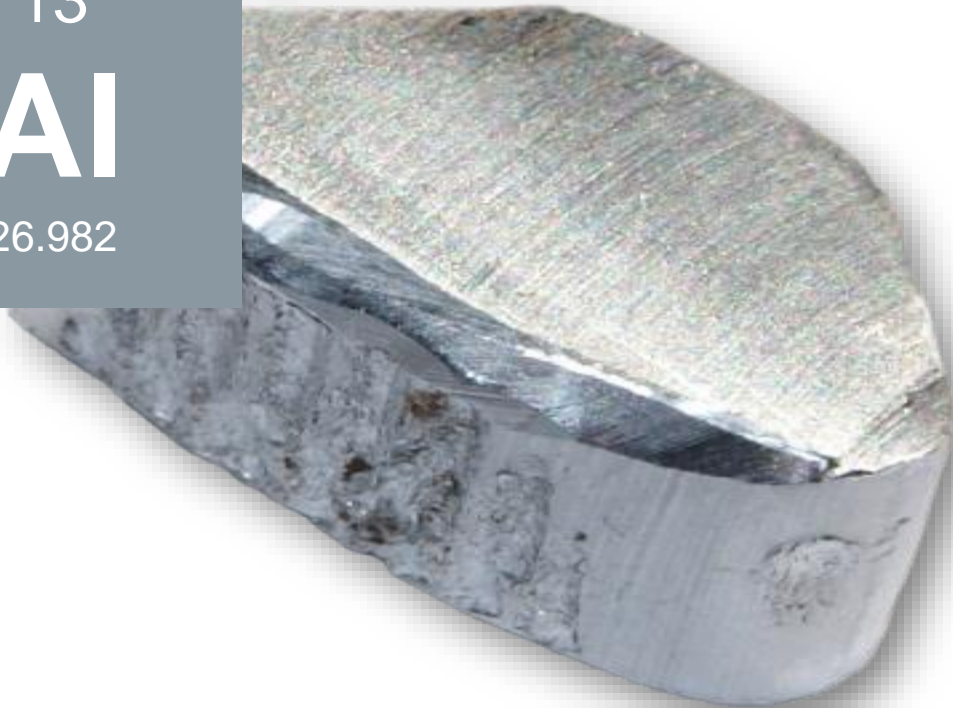
6000 Series (Most Common in Extrusion)

aluminium

13

Al

26.982



silicon

14

Si

28.086



magnesium

12

Mg

24.305



6063 Alloy

- Variants offered in 6063SPR and 6063HS
- **Advantages**
 - Good combination of mechanical strength and extrudability
 - Good surface appearance
 - Good formability
- **Disadvantages**
 - Less strength than 6061



6005A Alloy

- **Advantages**
 - Improved toughness over 6005
 - Improved strength over 6063
 - Improved surface appearance
 - Structural Alloy
 - Better extrudability over 6061



6061 Alloy

- **Advantages**
 - Good strength
 - Improved toughness over 6005A
 - Structural alloy
 - Certain grades have improved machinability
- **Disadvantages**
 - Surface not as good as 6005 or 6005A
 - Anodize properties not great



ACC-U-LINE™

6082 Alloy

- **Advantages**

- High mechanical strength
- High toughness
- Good fatigue properties
- Good machinability

- **Disadvantages**

- More expensive
- Not recommended for anodizing



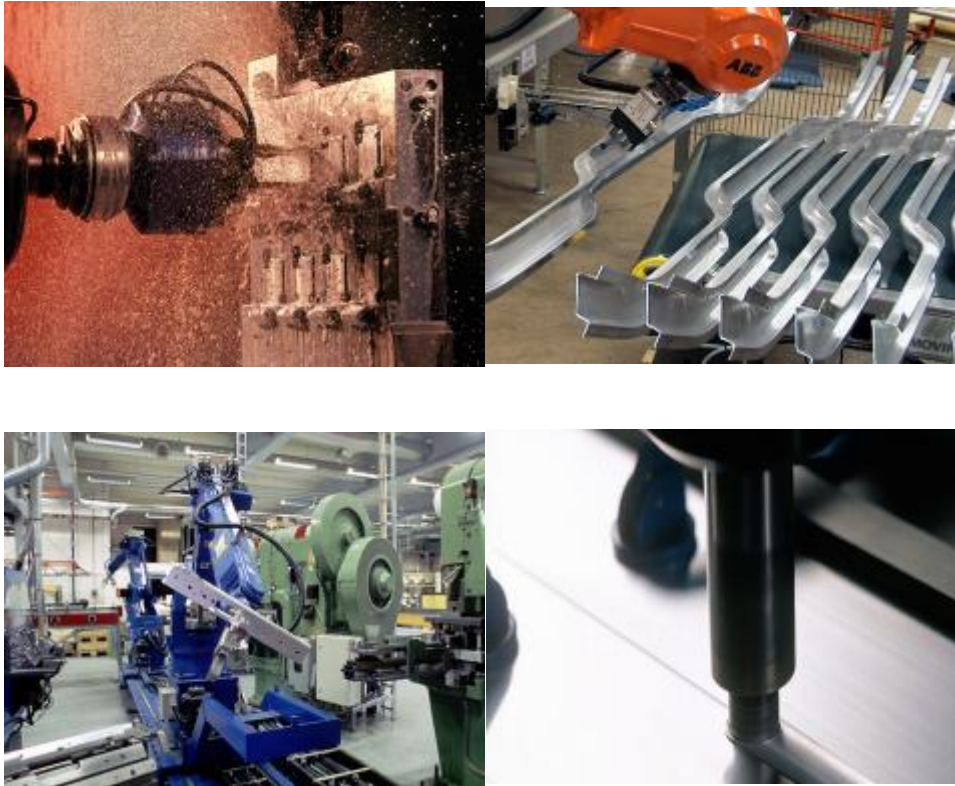
Extrusion Alloys



Alloy	Composition (weight %)					Mechanical Strength					
						Yield (MPa)		UTS (MPa)		Elongation (%)	
	Si	Fe	Cu	Zn	Mg	T4	T6/ T5	T4	T6/ T5	T4	T6
6063	0.20-0.6	0.35 max	0.10 max	0.10 max	0.45-0.9	65	170	130	215	14	8
6005	0.6-0.9	0.35 max	0.10 max	0.10 max	0.40-0.6	90	225	180	270	15	8
6005A	0.50-0.9	0.35 max	0.30 max	0.30 max	0.40-0.7	90	225	180	270	15	8
6060	0.30-0.6	0.10 -0.30	0.10 max	0.15 max	0.35-0.60		150		190	14	8
6061	0.4 - 0.8	0.7 max	0.15 -0.40	0.25 max	0.8 - 1.2	110	240	180	260	14	10
6082	0.7-1.3	0.50 max	0.10 max	0.2 max	0.6-1.2	110	260	205	310	14	10

Aluminum profile manufacturing

Aluminium extrusions can be easily fabricated to components





Arc & beam welding

Arc Welding

Basics:

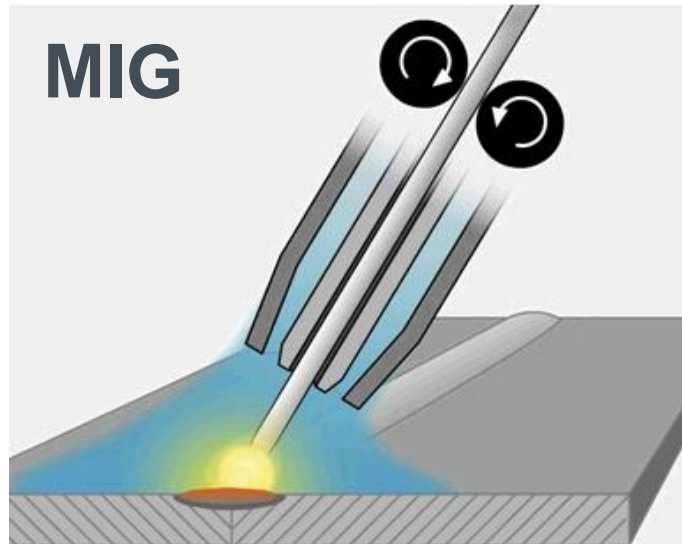
- Pointed heat source locally melts the workpieces
- Joint formed as molten pool solidifies
- Filler metal is typically used
- Shielding gas prevents oxidation

Common arc welding techniques:

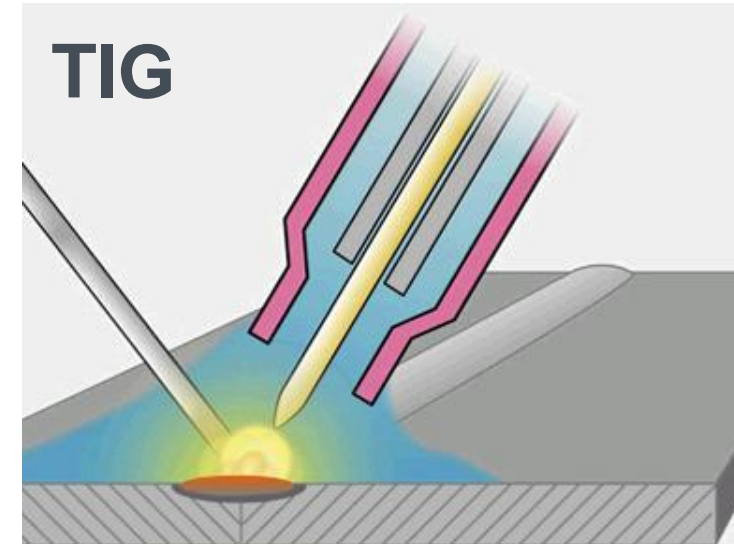
- Metal Inert Gas (MIG), also known as GMAW
- Tungsten Inert Gas (TIG), also known as GTAW
- Manual vs Automated



MIG and TIG



- Minimum metal thickness > 1mm
- Wire fed through the welding torch
- All weld positions and a variety of joint types
- Higher welding speeds yield higher productivity
- Robotic or manual welding



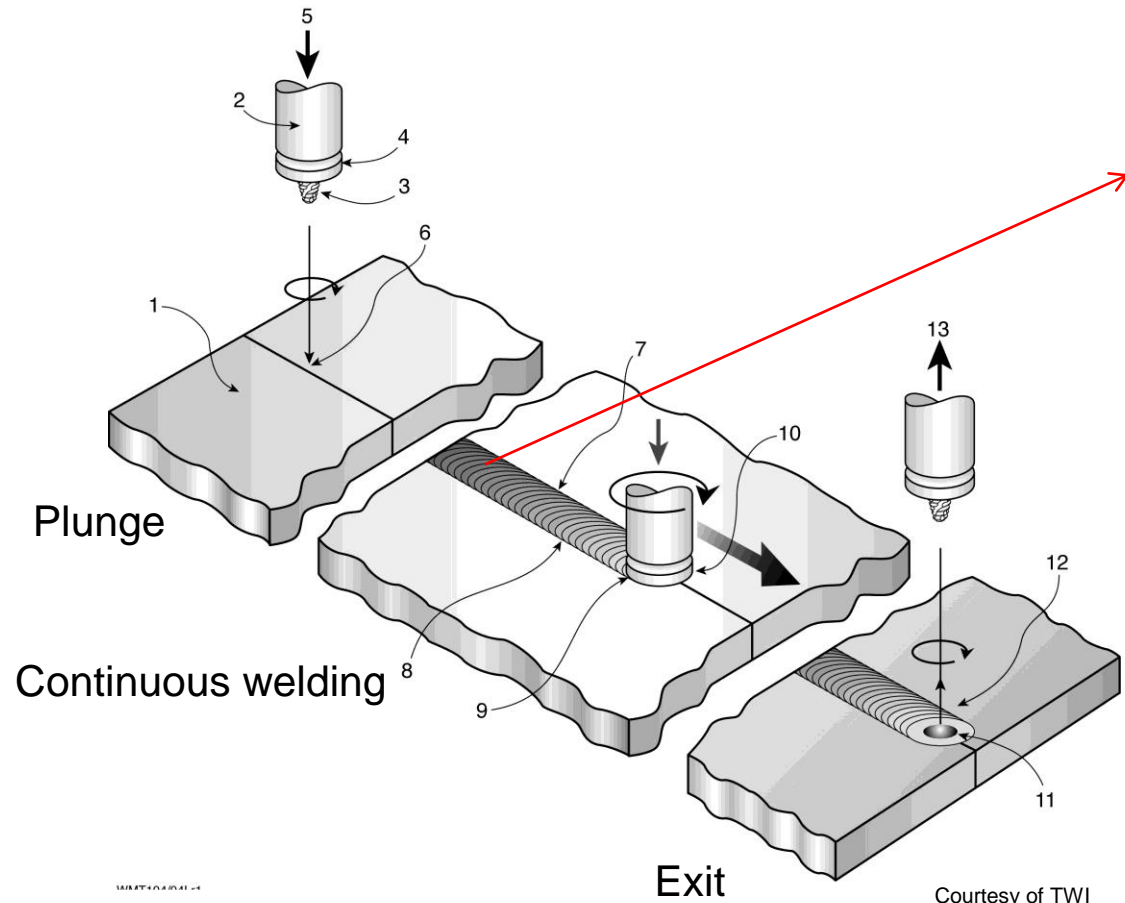
- Typical metal thickness: sub 1mm - 10mm
- Filler metal introduced from a side of the weld torch
- All weld positions and a variety of joint types
- Often used when appearance and performance are critical at the cost of lower productivity.



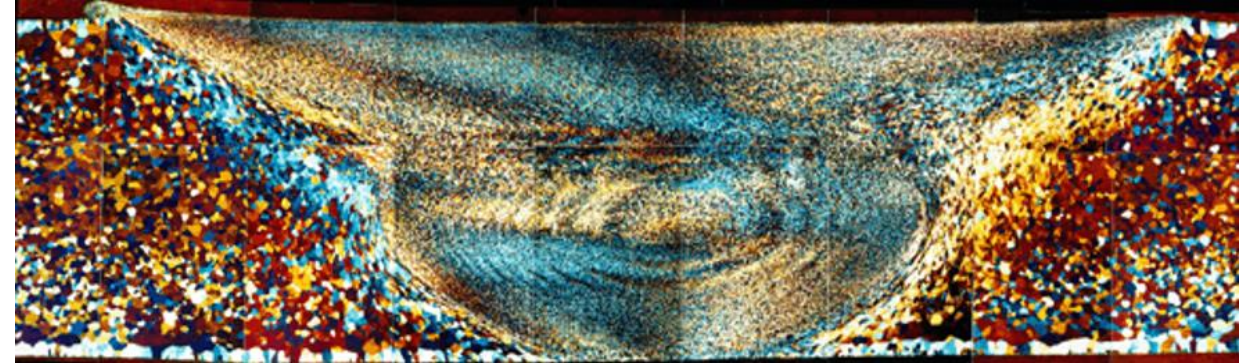
Solid state joining

Friction stir welding (FSW)

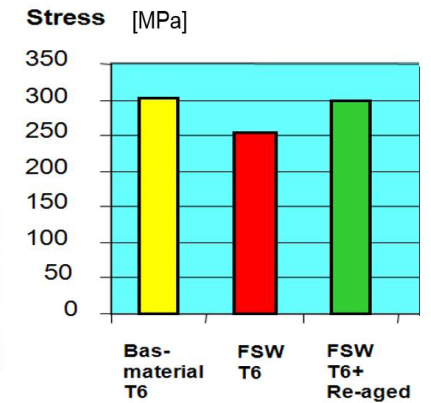
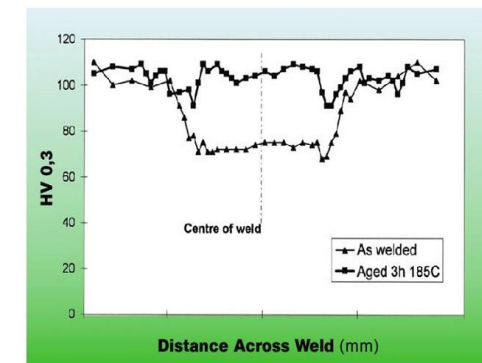
A solid-state joining method, no melting, low heat input, high mechanical strength and smaller distortion

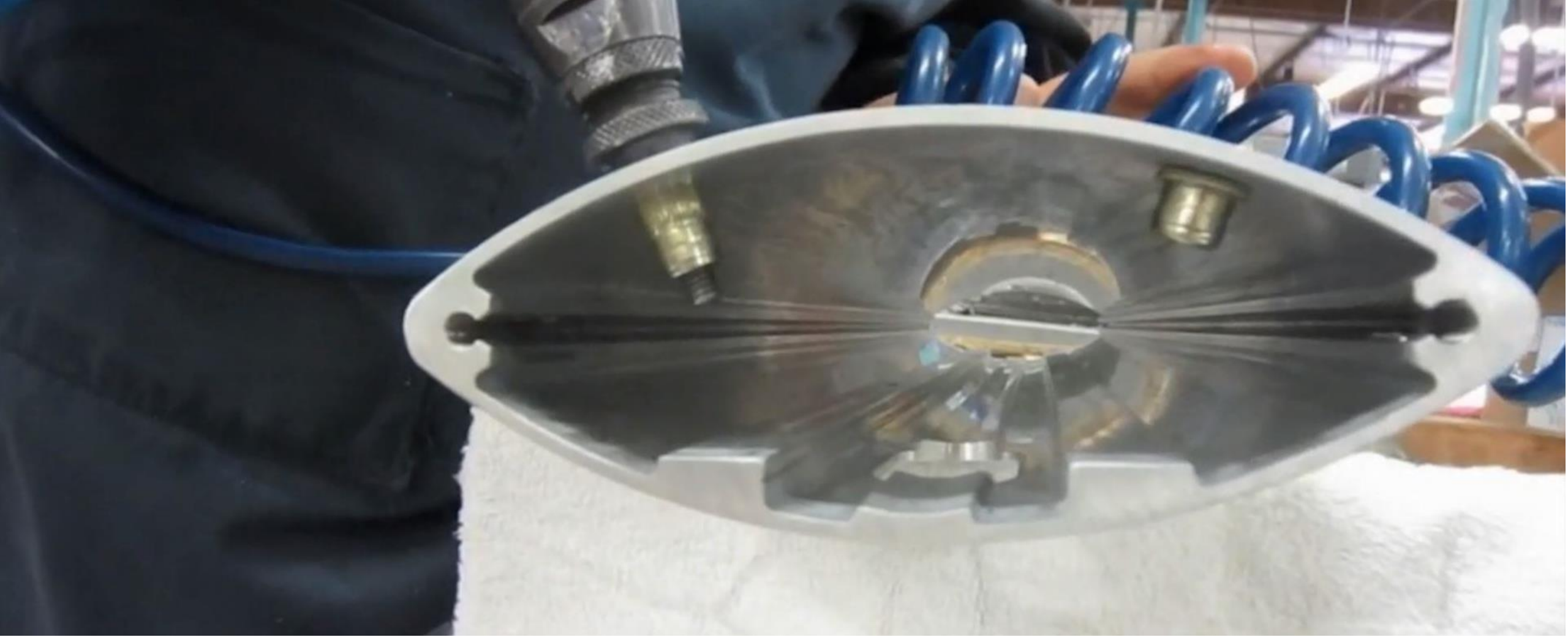


1. Workpiece
2. FSW tool
3. Pin
4. Shoulder
5. Plunge direction
6. Plunge
7. Advancing side
8. Retreating side
9. Advancing edge
10. Retreating edge
11. Exit hole
12. Exit
13. Exit direction



Grain structure of the weld

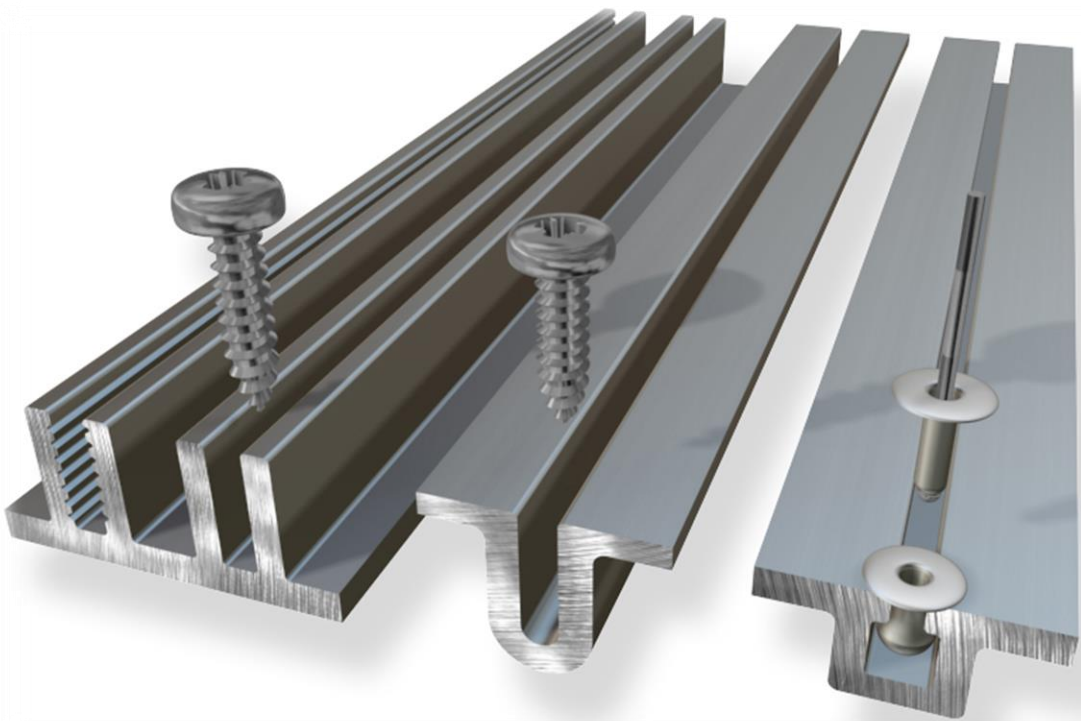




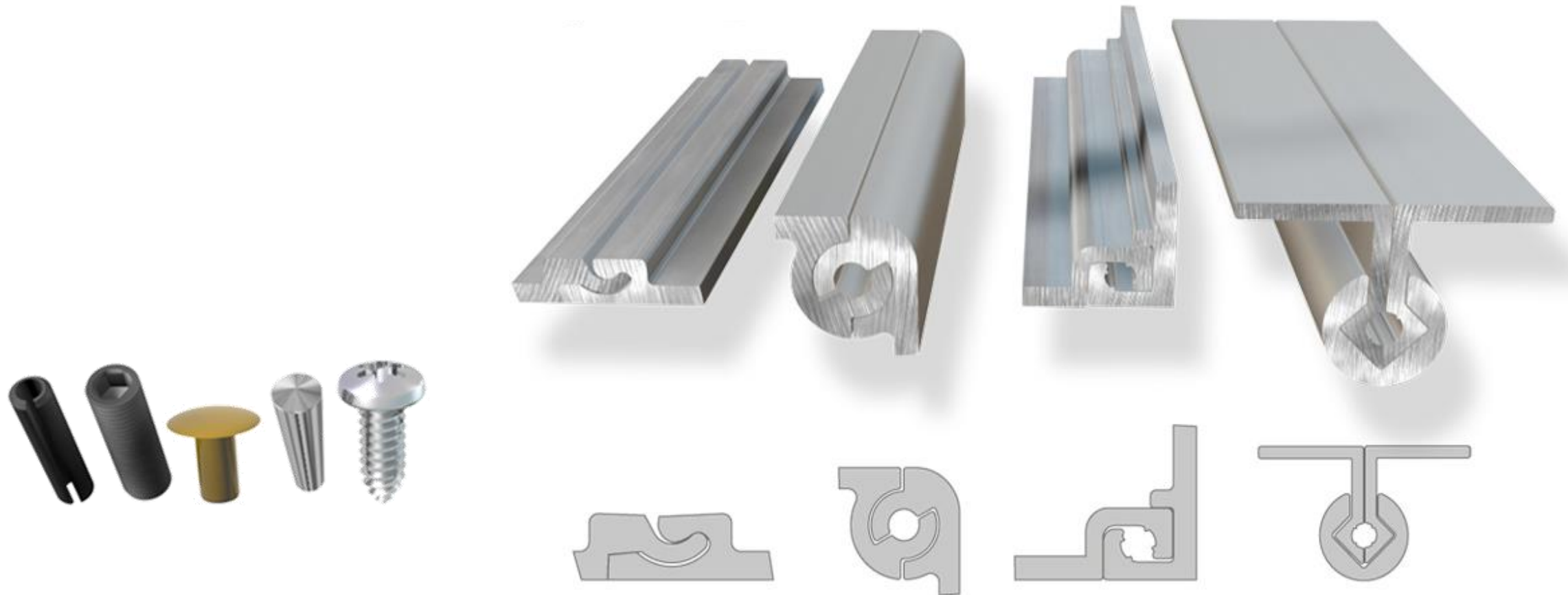
Mechanical Joining

Profile design vs fixings

Places for screwing



Profile design vs fixings



Rebites

Trade Names “RivNut”, “Blind Nut”, or “Nutsert”

- Working range: From 2 mm to 12 mm
- Varies depending on joint thickness and design
- Needs pre-drilling
- Can be used on tubular profiles
- Manual and automatic installation



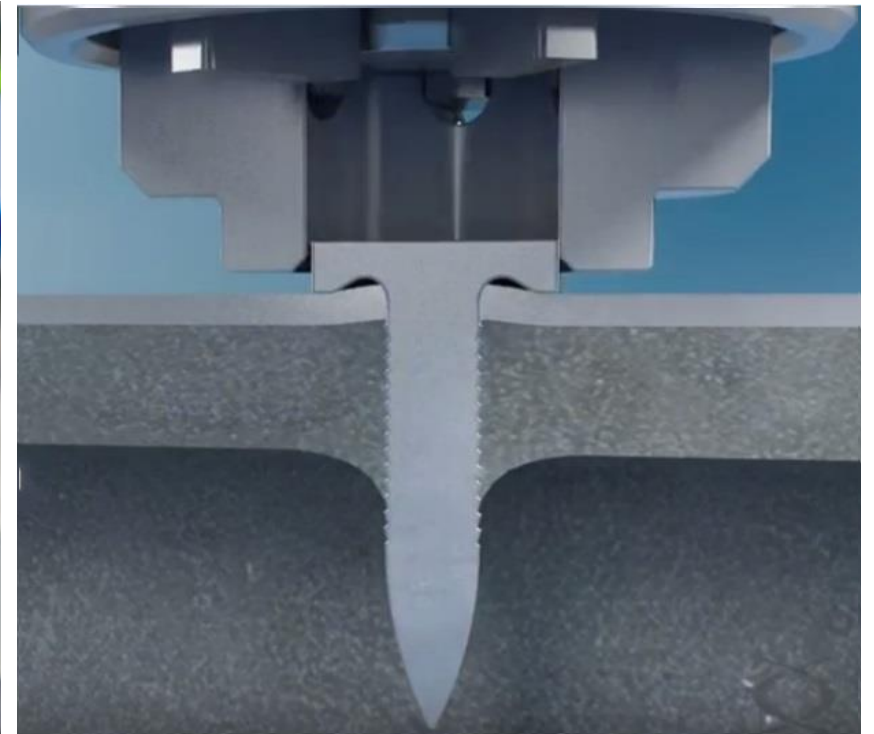
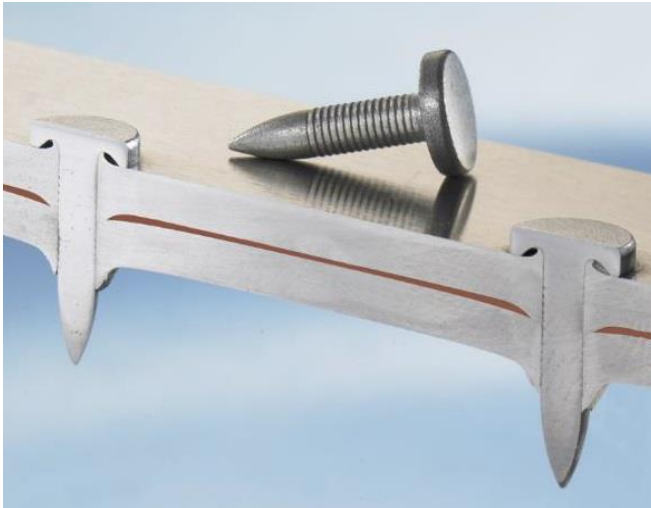
Self-Pierce Rivet (SPR)

- Working range: 2 mm to 6 mm.
- It does not require a pre-drilling.
- Requires access from both sides.
- Manual or atomic.
- Often combined with stickers.



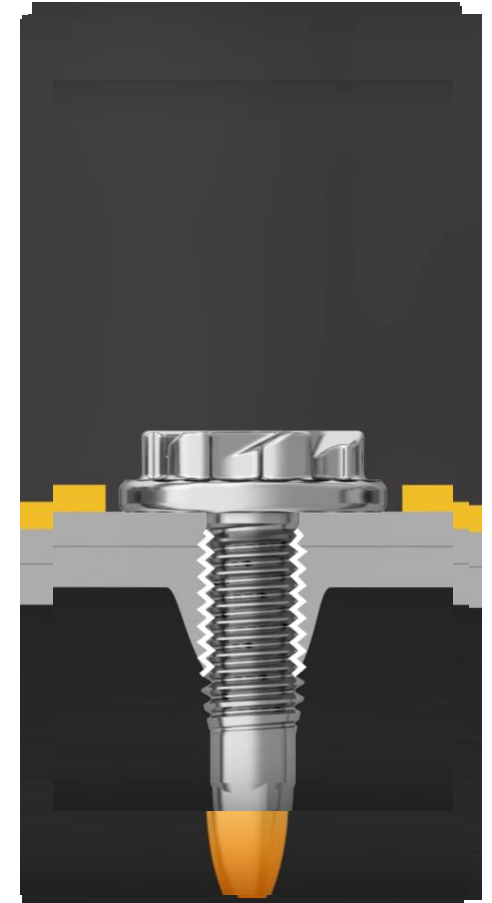
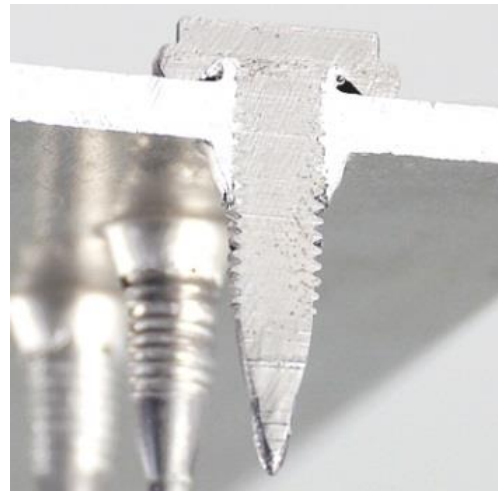
Tack joining

- Working range: 2 mm to 6 mm
- No pre-drilling required
- Applicable for hollow sections
- Combined with stickers



Flow Drill Screw

- Working range: 1 mm to 10+ mm
- Single-sided access
- Applicable for hollow sections
- Combined with stickers



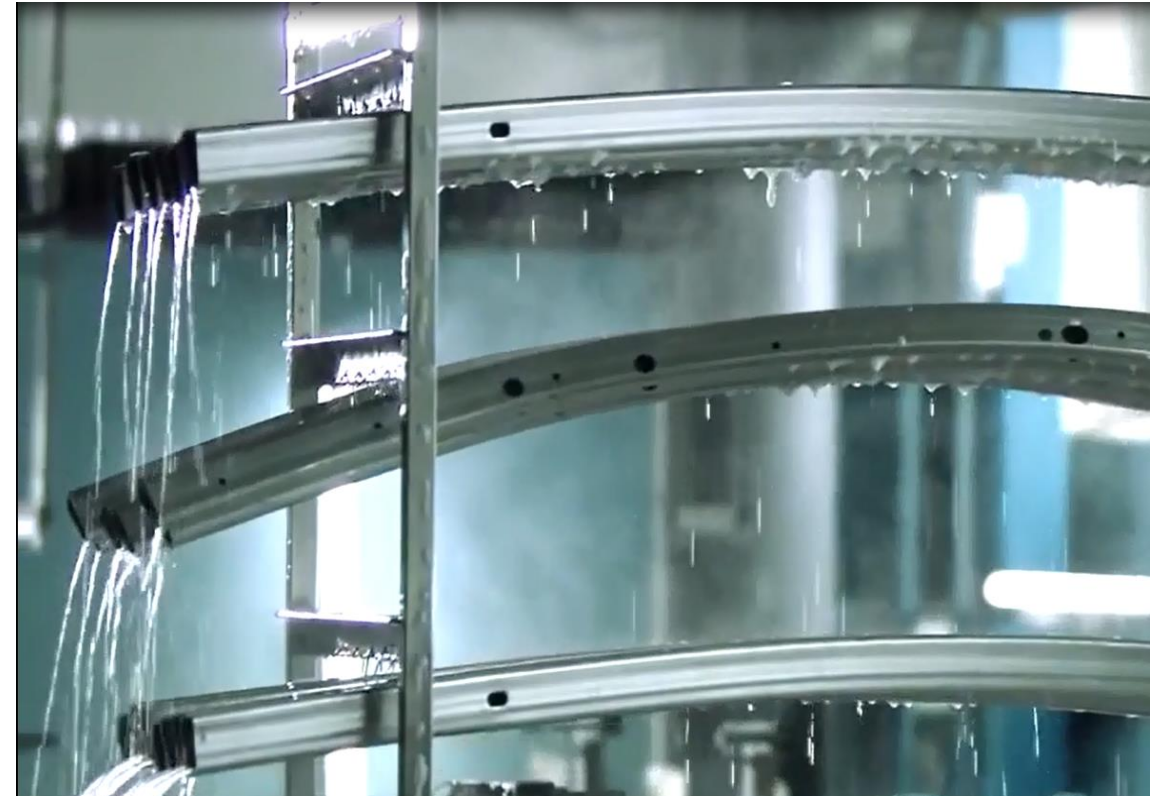
Sources: EJOT, Wibe Ladders, Stöger Automation



Adhesive

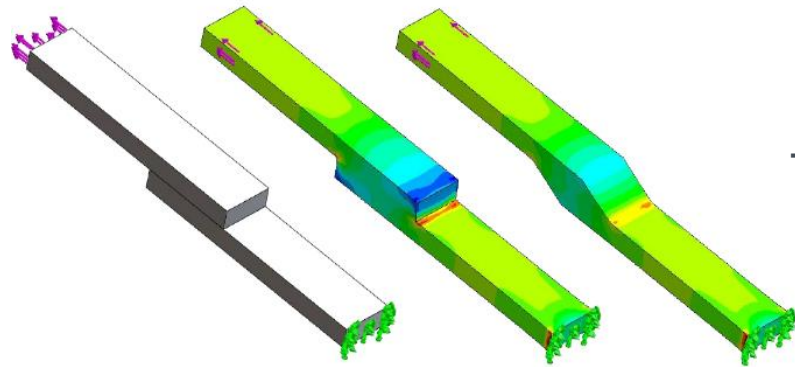
Surface pre-treatment

- Necessary for maximal performance and long-term strength
- **Pre-treatment methods**
 - Mechanical: grinding, brushing, blasting ...
 - Chemical: cleaning, degreasing, etching ...
 - Conversion coating: Alodine 5200, Alcoa 951 ...
 - Anodizing in phosphoric or sulfuric acid
 - Primers
- Any pre-treatment is better than none

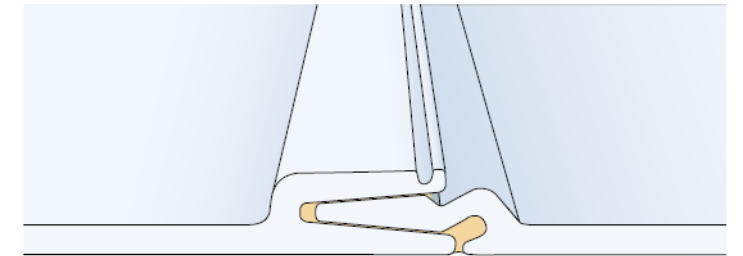
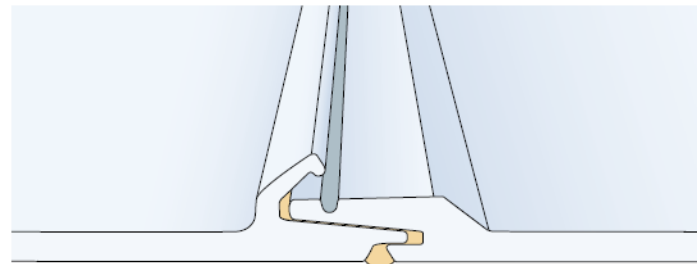
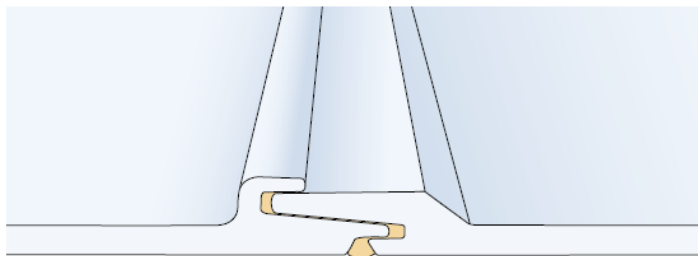
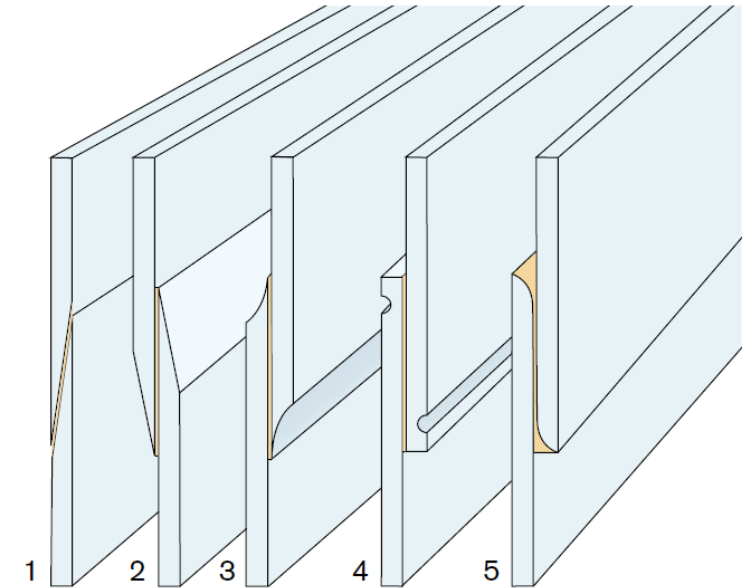


Profile Features for Adhesives

Profiles design to reduce stresses on adhesive joints:



Tapered edges reduce stress concentrations up to 25%



Hybrid joining techniques

- **Hybrid joining typical in structural components**
- **Adhesives have been combined with:**
 - Self piercing rivets
 - Blind rivets
 - Flowdrill screws
 - Rivtac
 - Resistance Spot Welding
 - Friction Stir Spot Welding



Source: Böllhoff Group

Choosing adhesive system



- Many adhesive system choices:
 - Epoxies, Acrylics, Urethanes, ...
- Many different forms:
 - Tape, Single part, Two part, ...
- How to navigate:
 - “Adhesive Bonding of Aluminum” by Hydro
 - “Automotive Aluminum Joining Manual” by The Aluminum Association
 - Turn to suppliers of adhesive and pre-treatment solutions





Hydro

Industries that matter