



GRÄNGES EUROPE

Rolled products for brazed heat exchangers

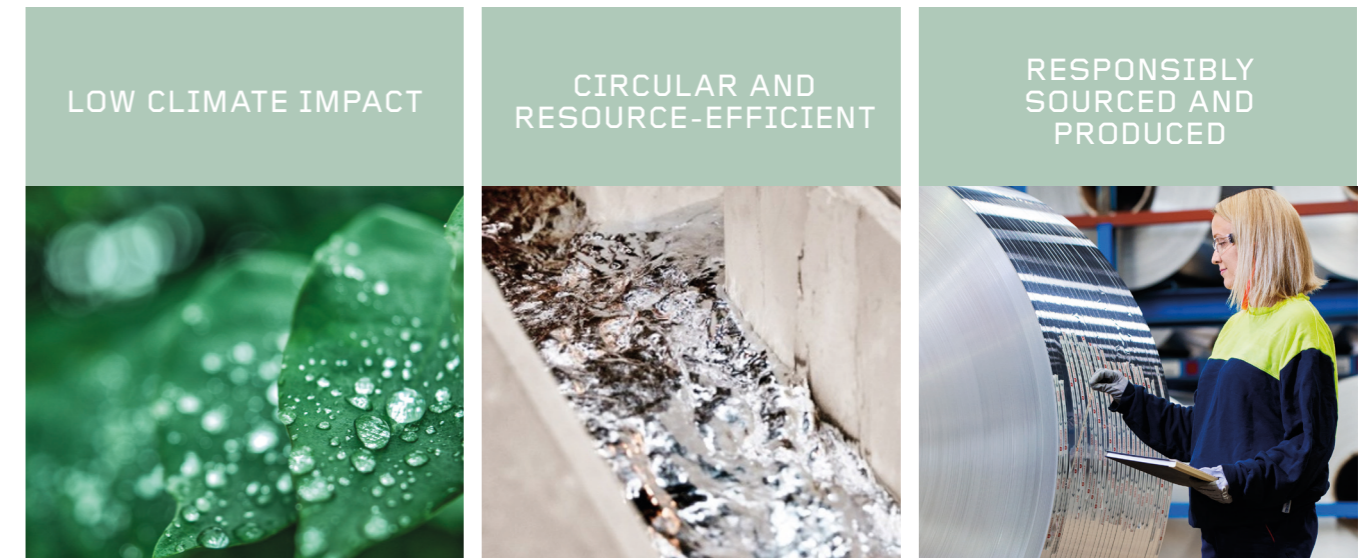
A GLOBAL LEADER IN ROLLED ALUMINIUM PRODUCTS

At Gränges we specialize in engineering and producing rolled aluminium products for heat exchangers and selected niche applications. Our end customers are in the automotive industry, the stationary heat exchanger industry, and niche markets including transformers and food packaging.

Within the industry for rolled products for brazed heat exchangers, Gränges is the global leader with a market share of approximately 20 per cent. Headquartered in Stockholm, Sweden, we have operations in Europe, China and the United States.



SUSTAINABLE ALUMINIUM SOLUTIONS



GRÄNGES COMMITS TO CLIMATE NEUTRALITY BY 2040

Gränges has been a leader in innovative aluminium solutions for decades. Today, the company has a demonstrated industry-leading sustainability performance. EcoVadis, the largest independent provider of business sustainability ratings, has for example awarded Gränges a Platinum rating which ranks the company in the top 1% of companies assessed globally in the industry.



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APPLICATION AREAS – ROLLED PRODUCTS

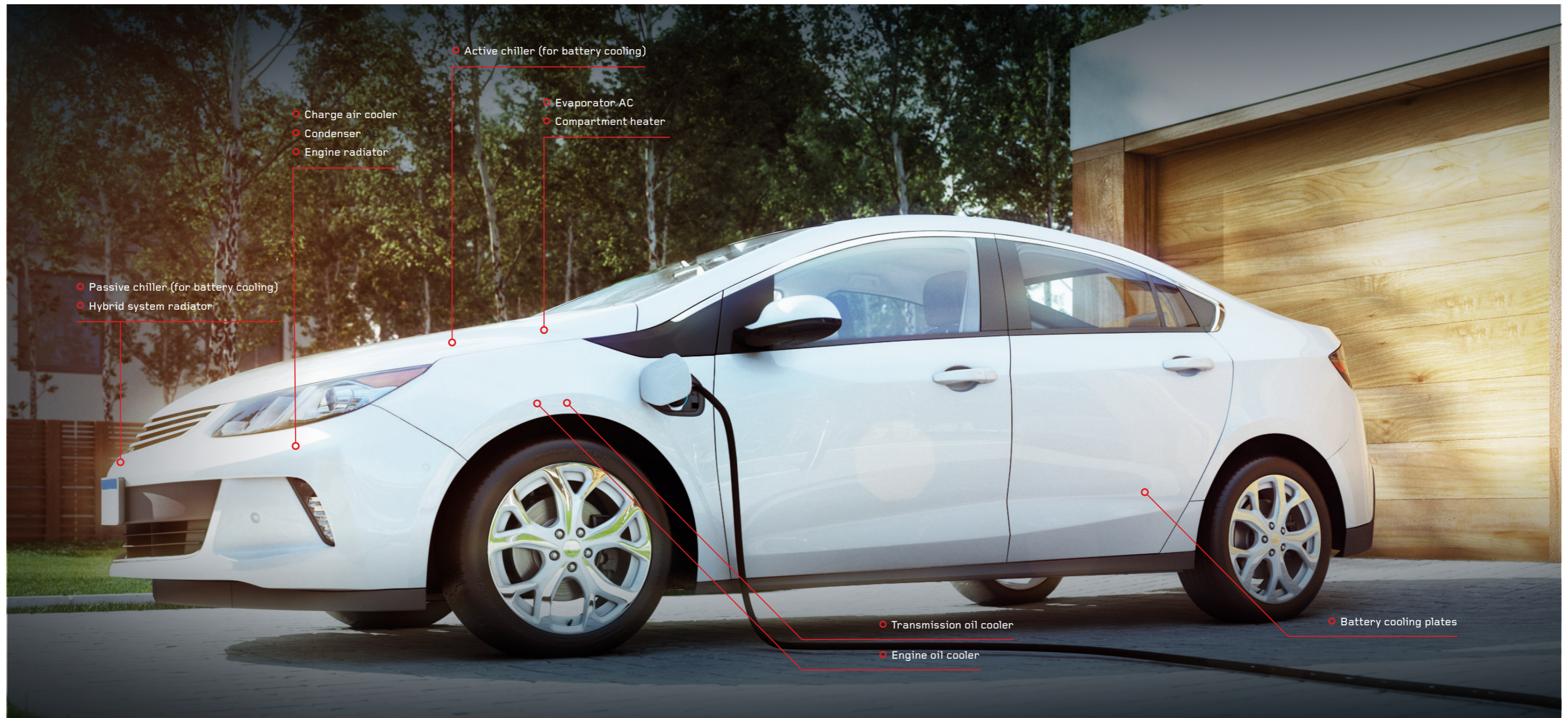
- Automotive heat exchangers
- Automotive heat shields
- Stationary heat exchangers (HVAC)
- Transformer windings
- Semirigid containers
- Food packaging

50%

EVERY SECOND CAR PRODUCED IN THE WORLD TODAY CONTAINS MATERIAL BY GRÄNGES

APPLICATION AREA - AUTOMOTIVE

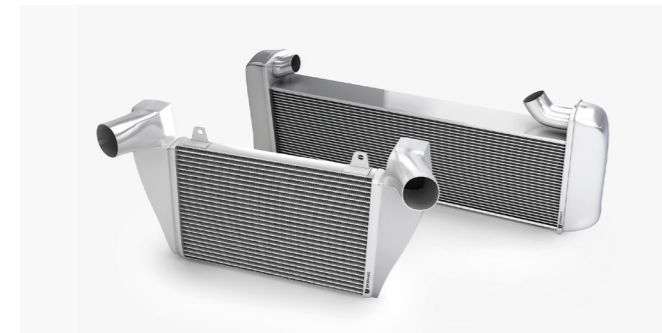
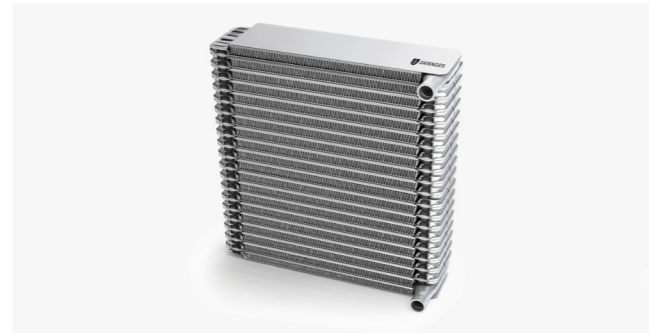
Gränges rolled products are used in a wide range of applications in the automotive industry. There are suitable material options for all types of vehicles, both with combustion engine and electric. Our high-performance materials increase the efficiency and effectiveness of heat transfer applications; from radiators and condensers to chillers and battery cooling plates.



TYPICAL APPLICATIONS

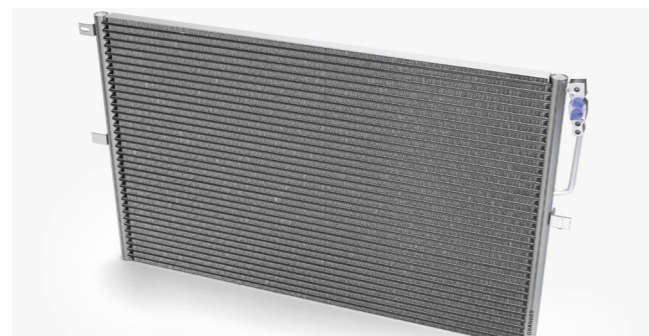
>> EVAPORATORS

The typical evaporator design is either a drawn cup plate design or a flat tube design made from extruded micro channel tubes. Further enhancement and size reduction of the evaporator has led to the introduction of a folded tube design. Reducing the weight and size of the unit drives the development of thinner material with higher strength, excellent corrosion resistance and brazing performance.



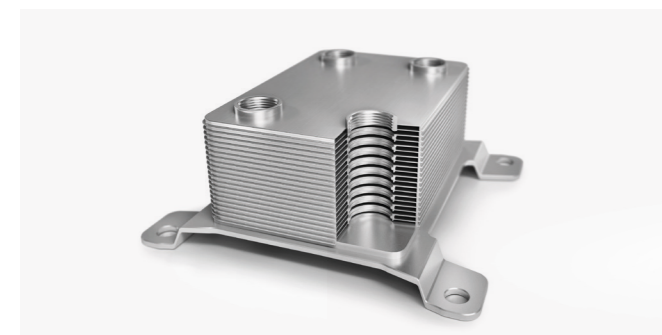
>> CHARGE AIR COOLERS

Charge air coolers operate under high temperature and pressure conditions, resulting in material requirements for sufficient strength at elevated temperatures. Typical tube designs are large rectangular welded tubes, with inserts or extruded tubes with internal webs.



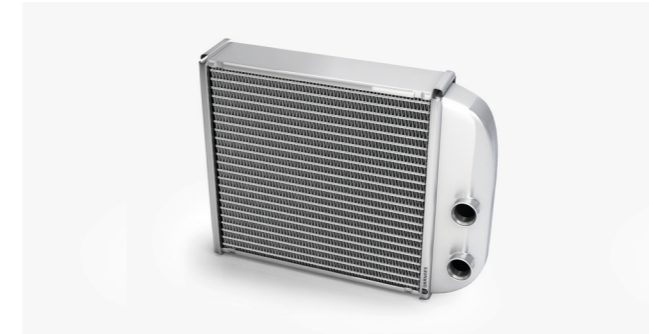
>> CONDENSERS

The most common condenser design is the parallel flow condenser with extruded multiport tubes. Over recent years, alternatives with folded tube design have become common. The downgauging trend places very high demands on the clad fin in terms of sag-resistance and strength. As well as this, the trend towards more folded tubes increases the demands on brazeability.



>> CHILLERS

The need of chillers have increased with electrification of vehicles. A chiller is typically designed with stacked plates and it requires material with both good formability and brazeability. Depending on cooling circuit requirement; conductivity and flux residue could play an important role in design and material selection.



>> HEATERS

For heaters, a strong downgauging trend has been ongoing for many years, increasing demands on corrosion performance and brazeability. The corrosion-resistant alloy system used in heaters consists, in many cases, of a long-life tube alloy and a zinc containing fin, where the fin protects the tube via galvanic action.

>> OIL COOLERS

Oil coolers come in many different designs. Due to service conditions with high pressure and temperatures, the main material requirements are strength, corrosion resistance, and brazeability. Depending on performance needs and the positioning of the coil cooler, it can either be an air-cooled heat exchanger or a coolant-based heat exchanger.



>> RADIATORS

The radiator is typically made of a tube and fin design, where the tubes are either welded or folded. A strong downgauging trend has been ongoing for radiators for many years, increasing demands on the corrosion performance, brazeability, and fatigue strength. The corrosion-resistant alloy system used in radiators consists, in many cases, of a long-life tube alloy and a zinc containing fin, where the fin protects the tube via galvanic action.

>> BATTERY COOLING PLATES

The batteries of electrical vehicles require cooling. The most common solution is cooling plates of aluminium. It can be several small or one large plate with formed channels. Usually the cooling plate is produced from one clad and one unclad aluminum material that are brazed together. Depending on the design and position in the vehicle, there could be additional requirements on both strength and corrosion.



FIN PRODUCTS

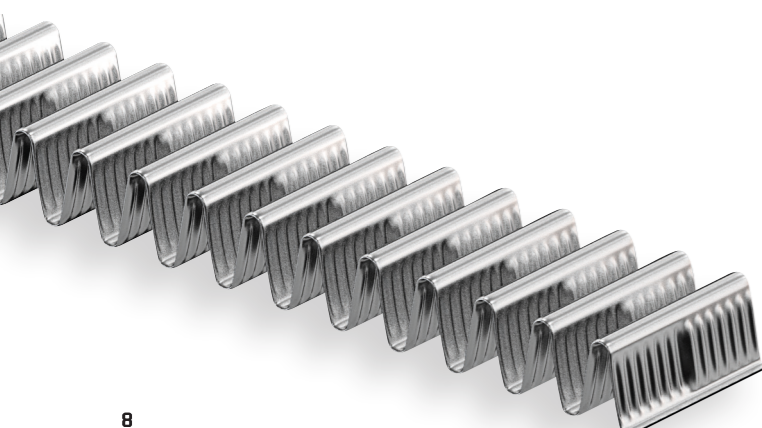
Our rolled fin products range offers performance characteristics tailored to each specific application requirement in terms of strength, sustainability and sag resistance.

Alloy		Sustainability		Area of use		Typical mechanical and corrosion properties in post braze condition		
EN std	Gränges	Carbon footprint* [tCO ₂ e/t]	Ability to absorb recycled and remelted material**	Zn-content [%]	Cladded	R _{p0,2} [MPa]	R _m [MPa]	Free corr. pot. [mV vs SCE]
EN AW 3003	FA5577	4-5	MEDIUM	<0.10	YES/NO	40	110	-715
mod 3003	FA6800	4-5	MEDIUM	0	YES/NO	50	130	-730
mod 3003 with Zn	FA6807	4-5	HIGH	0.7	YES/NO	50	130	-750
	FA6815	4-5	HIGH	1.5	YES/NO	50	130	-800
	FA6825	4-5	HIGH	2.5	YES/NO	50	130	-880
	FA7999	<4	HIGH	1.5	NO	50	140	-760
	FA7041	<4	HIGH	2.4	NO	50	140	-800
	FA6809	4-5	HIGH	0.7	YES	65	155	-750
	FA6817	4-5	HIGH	1.5	YES	65	155	-800
	FA6827	4-5	HIGH	2.5	YES	65	155	-880
	3003+Zn	>5	MEDIUM	1.5	YES	50	130	-800
	HF421	>5	MEDIUM	1.5	NO	50	130	-800
HF422	>5	MEDIUM	0.7	NO	50	130	-760	

Values given for standard H14/16 temper. Other tempers available upon request.

* Product carbon footprint data from 2021, third-party verified. Variation on PN level, due to validated slab supplier and added clad layers.

** From internal and external sources



TUBE PRODUCTS

Our rolled tube product range offers distinct benefits in terms of strength, heat treatability and corrosion resistance, depending on the demands of the application.

Alloy		Sustainability		Area of use			Typical mechanical and corrosion properties in post braze condition		
EN std	Gränges	Carbon footprint* [tCO ₂ e/t]	Ability to absorb recycled and remelted material**	Mg-content	Age hardenable	Improved corrosion resistance	R _{p0,2} [MPa]	R _m [MPa]	Free corr. pot. [mV vs SCE]
EN-AW 3003	FA5577	4-5	MEDIUM	None	NO		40	110	-715
mod 3003	FA7929	4-5	HIGH	None	NO	Ti-effect	60	165	-690
	FA7888	4-5	HIGH	None	NO	Ti-effect	60	165	-690
mod 6060	FA7850	<4	HIGH	High	YES	Ti-effect	75	190	-710
EN-AW 3005	FA7805	>5	LOW	Intermediate	NO	LL	55	145	-695
mod 3003 Long life	FA6519	4-5	LOW	High	NO	LL	60	170	-695
	FA7857	>5	LOW	None	NO	SLL	50	140	-690
	FA7948	>5	LOW	Intermediate	NO	SLL	60	165	-675
	FA7031	>5	LOW	High	NO	SLL	60	165	-675
	FA7873	4-5	LOW	None	NO	SLL	55	155	-660
	HF435	>5	LOW	Intermediate	NO	LL	50	155	-710
	HF436	>5	LOW	None	NO	LL	50	145	-700

Values given for standard H24 temper. Other tempers available upon request.

* Product carbon footprint data from 2021, third-party verified. Variation on PN level, due to validated slab supplier and added clad layers.

** From internal and external sources

Gränges' MULTICLAD™ material is developed for the most demanding applications, with high requirements on strength and corrosion resistance. It is a multilayer tube concept where a selected core alloy is combined with a tailored interlayer and braze clad in more than 3 layers. A wide range of selectable clads are presented on page 12.



PLATE PRODUCTS

Our rolled plate products offer varying characteristics of strength, enhanced corrosion resistance, hardening and composition to cover the widest range of heat exchanger applications.

Alloy		Sustainability		Area of use			Typical mechanical and corrosion properties in post braze condition		
EN std	Gränges	Carbon footprint* [tCO ₂ e/t]	Ability to absorb recycled and remelted material **	Mg-content	Age hardenable	Improved corrosion resistance	R _{p0.2} [MPa]	R _m [MPa]	Free corr. pot. [mV vs SCE]
EN AW 3003	FA5577	4-5	MEDIUM	None	NO		40	110	-720
mod 6060	FA7850	<4	HIGH	High	YES	X	75-90***	190	-700
mod 3003	FA7915	4-5	HIGH	None	NO	X	55	160	-705
	FA7021	4-5	HIGH	None	NO	X	60	165	-680
	FA7975	4-5	HIGH	Inter-mediate	NO	X	65	170	-680
	LH436	>5	LOW	None	NO	X	50	140	-700

Values given for standard 0-temper. Other tempers available upon request.

* Product carbon footprint data from 2021, third-party verified. Variation on PN level, due to validated slab supplier and added clad layers.

** From internal and external sources

*** With controlled cooling rate



Gränges' MULTICLAD™ material is developed for the most demanding applications, with high requirements on strength and corrosion resistance. It is a multilayer plate concept where a selected core alloy is combined with a tailored interlayer. A wide range of selectable clads are presented on page 12.

BATTERY COOLING PLATE PRODUCTS

Our material solutions for brazed aluminium battery cooling plates offer low carbon footprint and performance benefits in terms of strength, corrosion resistance, hardening and composition to cover all your needs for the thermal management of Li-ion batteries.

Alloy		Sustainability		Area of use		Typical mechanical and corrosion properties in post braze condition		
EN std	Gränges	Average carbon footprint [tCO ₂ e/t]	Ability to absorb recycled material **	Mg-content	Age hardenable	R _{p0.2} [MPa]	R _m [MPa]	Free corr. pot. [mV vs SCE]
EN AW 3003	FA5577	4-5	MEDIUM	None	NO	40	110	-720
mod 3003	FA7915	4-5	HIGH	None	NO	55	160	-705
	FA7021	4-5	HIGH	None	NO	60	165	-680
	FA7975	4-5	HIGH	Intermediate	NO	65	170	-680
	FA7994	4-5	LOW	None	NO	50	160	-680
	LH436	>5	LOW	None	NO	50	140	-700
	modLH436	>5	LOW	None	NO	60	145	-690
mod 6060	FA7850	<4	HIGH	High	YES	75-90***	190	-700

Values given for standard 0-temper. Other tempers available upon request.

* Product carbon footprint data from 2021, third-party verified, assuming standard braze clad

** From internal and external sources

*** With controlled cooling rate



SELECTABLE CLADS

Our comprehensive range of selectable clad products spans CAB, vacuum, waterside cladding variants and interlayers for MULTICLAD concept. The most common alloys per variant presented on this slide. Customer specific alloys can be created up on request.

Braze clad - CAB

Alloy		Chemical composition, interval or max [weight-%]							
Standard	Si	Fe	Cu	Mn	Mg	Zn	Ti	Zr	Others
EN AW 4343*	6.8-8.2	0.25	0.25	0.10	-	0.20	-	-	0.15
	6.8-8.2	0.8	0.25	0.10	-	0.20	-	-	0.15
EN AW 4045*	9.0-11.0	0.25	0.3	0.05	0.05	0.10	-	-	0.15
	9.0-11.0	0.8	0.3	0.05	0.05	0.10	-	-	0.15
AA4047	11.0-13.0	0.8	0.30	0.15	0.10	0.20	-	-	0.15

*Can be modified with Zn-addition

Braze clad - Vacuum

Alloy		Chemical composition, interval or max [weight-%]							
Standard	Si	Fe	Cu	Mn	Mg	Zn	Bi	Zr	Others
AA4004	9.0-10.5	0.8	0.25	0.10	1.0-2.0	0.20	-	-	0.15
AA4104	9.0-10.5	0.8	0.25	0.10	1.0-2.0	0.20	0.02-0.20	-	0.15
low Mg - FA7772	9.0-10.5	0.8	0.25	0.10	0.6-1.5	0.20	-	-	0.15
low Mg - FA7856	9.0-10.5	0.8	0.25	0.10	0.6-0.8	0.20	0.02-0.20	-	0.15

Waterside cladding

Alloy		Chemical composition, interval or max [weight-%]							
Standard/Gränges	Si	Fe	Cu	Mn	Mg	Zn	Ti	Zr	V
AA3003	0.6	0.7	0.05-0.20	1.0-1.5	0.1	0.1	-	-	-
AA7072	Fe + Si max 0.7	-	0.10	0.10	0.8-1.3	0.8-1.3	-	0.15	-
FA6815	0.65-1.0	0.7	0.10	1.4-1.8	0.03	1.2-1.8	-	0.05-0.20	-
FA6825	0.65-1.0	0.7	0.10	1.4-1.8	-	2.2-2.8	-	0.05-0.20	-
HF421	0.7-1.1	0.1-0.5	0.05	1.4-1.8	0.05	1.3-1.8	0.05-0.25	-	0.03-0.20

Interlayer alloys

Alloy		Chemical composition, interval or max [weight-%]							
Standard/Gränges	Si	Fe	Cu	Mn	Mg	Zn	Ti	Zr	V
FA6802	0.40-0.70	0.4	0.04	1.4-1.8	-	0.10	-	0.05-0.20	-

TRILLIUM®: ACTIVE BRAZING TECHNOLOGY

TRILLIUM® is an innovative rolled aluminium product that has all the fluxing agents built-in. It enables our customers to reduce costs, create new designs, and achieve better profitability, while reducing their environmental impact.

TRILLIUM® LEAN

TRILLIUM®Lean is a multilayer braze clad that can be offered within the chemical composition of all standard 4xxx braze clads on the market. The total clad layer thickness is flexible in the same range (4-18%) as standard braze clads. It can be combined with all core alloys in Gränges portfolio and used in all types of applications. The concept has unique properties and proven brazing performance, even at a low flux load as 100mg/m². It reduces the flux residues in the system dramatically compared to conventional fluxing.

Using TRILLIUM® Lean it is important that application design and material selection are made in close cooperation between application manufacturer and Gränges.



TRILLIUM® SOLID

The original TRILLIUM® Solid was launched in 2010. With its unique formation of uniform flux and silicon particles, TRILLIUM® Solid has numerous advantages built-in and represents a major advancement in brazing technology. It features excellent brazing activity and robustness in sub-optimal atmospheric conditions. This means that it could be the key to solve complicated design and brazing dilemmas.



GRÄNGES ENDURE - SUSTAINABLY SOURCED AND PRODUCED

Gränges' strategic priority is to offer customers industry-leading sustainable products and solutions that have a low climate impact, are circular and resource efficient as well as responsibly sourced and produced.

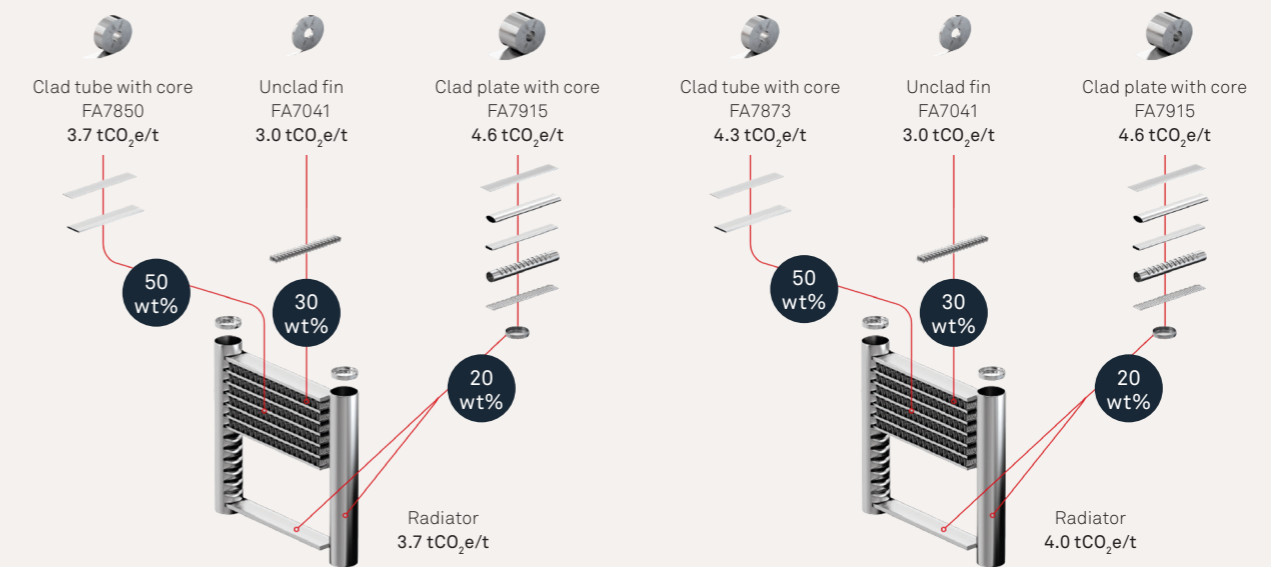
In 2022 Gränges launched a new product brand for sustainable and circular solutions. Gränges Endure will help our customers decarbonize their products and meet the demands of climate conscious end-users.

Gränges Endure products have a third-party verified carbon footprint of maximum 4.0 tonnes CO₂e/tonne, measured from extraction of bauxite to the delivery of Gränges' products to customers (cradle-to-gate). The products are also verified by a third party to be responsibly sourced and produced.

CUSTOMER CASE

How to build a radiator with less than 4tCO₂e/t using Gränges' alloys with high ability to absorb recycled and remelted material.

How to build a radiator with 4tCO₂e/t using Gränges' long-life tube.



* Data from Gränges, 3rd party verified, 2021 LCA-model. Weight assumptions and share per part are based on a typical light vehicle's radiator.

» Helping our customers decarbonize

» Meeting demands of climate-conscious end-users

» Offering the highest quality with the lowest sustainability impact



GRÄNGES ENDURE – OUR NEW PRODUCT BRAND FOR SUSTAINABLE AND CIRCULAR SOLUTIONS

- ✓ Carbon footprint at maximum 4.0 tCO₂e/t, cradle-to-gate
- ✓ Third-party verified carbon footprint
- ✓ Third-party verified responsibly sourced and produced



GRANGES

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