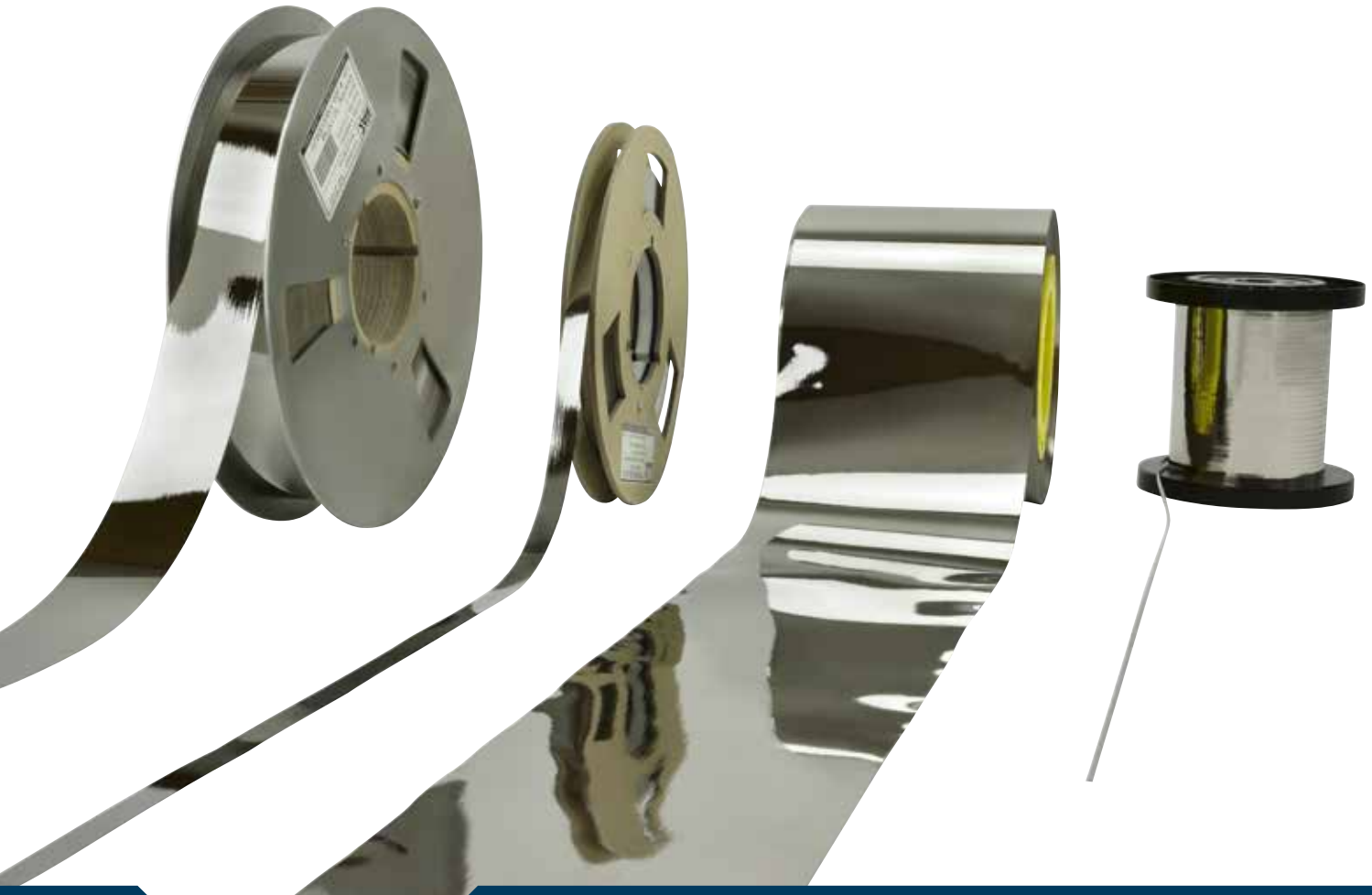
VITROBRAZE

AMORPHOUS BRAZING FOILS



ADVANCED MATERIALS – THE KEY TO PROGRESS

VACUUMSCHMELZE

THE COMPANY
VACUUMSCHMELZE

We are a global company with our headquarter in Hanau, Germany. We currently have over 4300 employees who are spread over production and sales locations in more than 40 countries on every continent generating annual sales of approximately EUR 400 million.

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Advanced Materials – The Key to Progress

VACUUMSCHMELZE is one of the world's leading companies in the field of development, production and application know-how of magnetic and special materials. VAC's research and development is dedicated to ensuring technology leadership through close contact to our customers.

One of the first vacuum melting furnaces, approx. 1923

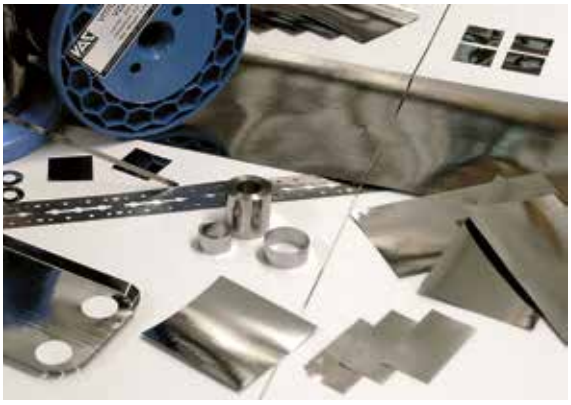
VACUUM INDUCTION MELTING

VAC was the first company to introduce the melting of alloys under vacuum on an industrial scale, producing Ni, Fe, Co and Cr alloys with reduced levels of C,N,O and H, as well as low levels of non metallic inclusions (oxides, nitrides and carbides).
The high purity and homogeneity associated with tight tolerances of chemical composition are fundamental for the production of alloys with superior soft magnetic or other unique physical properties, including the production of high grade Rare Earth permanent magnets.

MATERIALS DESIGN

Our ability to tailor the composition and all further processing steps according to our proprietary know-how enables us to design alloys with unique properties for specific customer needs.
Our unique material production routes, such as conventional hot and cold rolling, powder metallurgy or rapid solidification, start with in-house melting under vacuum conditions.

VACUUMSCHMELZE has outstanding knowledge of the material properties as well as the possibilities for processing them. Our expertise in material design and processing combined with our knowledge of markets and applications secures the development of advanced materials. Our products and technologies are driven by customer requirements. We work with our customers to define material-based solutions that perfectly match their requirements.



A variety of different types VITROBRAZE brazing foils and stamped or cut preforms

QUALITY ASSURANCE SYSTEM

The quality system at VACUUMSCHMELZE is certified according to DIN EN ISO 9001:2015, for the requirements of the automotive industry to IATF 16949:2016, and for the requirements of the aerospace industry to DIN ISO 9100:2018. Furthermore, VACUUMSCHMELZE has implemented and maintains an environmental management system according to ISO 14001:2015.

VITROBRAZE

By considering the 5000 years of brazing history, the nickel based filler metals are a very young group of materials. The first Nickel-BFM (Brazing Filler Metal) was developed for joining parts of jet engines in 1947. This new group of BFMs and the according brazing procedures were therefore continuously improved in the following decades. Modern alloys of this BFM group are mainly optimized for corrosion resistance and joint strength.

Our amorphous VITROBRAZE® filler metal foils are produced by the Rapid Solidification Technology which is also used for our soft magnetic VITROVAC® and VITROPERM® products. The production of amorphous metals requires a manufacturing technology that operates on the basis of the extremely fast cooling rates, which is known as rapid solidification. Amorphous structures are characterized by the absence of a crystal lattice or a long range order. With this random, spatially uniform arrangement of the constituent atoms, their structure is similar to that of liquids.

VITROBRAZE for EGR cooler production

The nature of this production process is the reason why amorphous alloys are offered in the form of thin, ductile metal foils. Subsequently, tapes, parts and preforms can be made by e.g. slitting, cutting, stamping and etching.

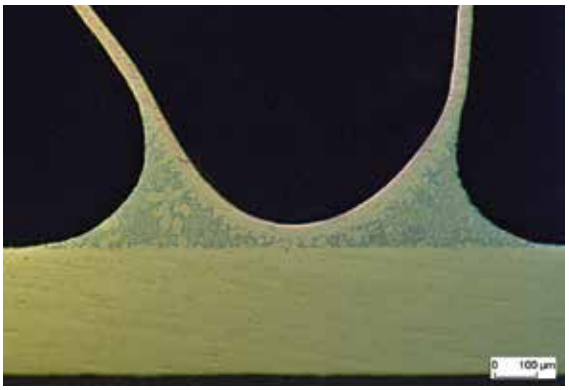
APPLICATIONS OF VITROBRAZE

Nickel filler metals are used for applications where corrosion, oxidation and heat resistance are necessary. A primary benefit is the ability to endure high-temperature service, even in moderately aggressive environments. They are also suitable for sub-zero applications. Nickel brazing foils are used for brazing heat exchangers, EGR coolers, metallic catalysts, food handling components, medical devices, as well as marine and automotive applications. Brazing joints made with VITROBRAZE show a consistence performance with non-porous and leak free joints. Nickel filler metals can be used for brazing low carbon and stainless steels, nickel and nickel alloys, cobalt and cobalt alloys, and in some cases for special metals and their alloys.

A micrograph of the cross section of a stainless steel EGR cooler brazed with VITROBRAZE VZ2170

Nickel-Iron filler metals are recently developed brazing alloys for joining stainless steel. Primarily, these alloys are optimised for the mass production of heat exchangers made of stainless steel, for example EGR coolers.
These alloys are lower in cost compared to amorphous nickel filler metals due to their lower nickel content.
Joint performance and corrosion resistance are comparable to the well known high-chromium nickel brazing alloys.

Copper filler metal foils are very low melting point brazing alloys. They are mainly used for a fluxfree brazing of copper and its alloys. These filler metals contain no cadmium or lead. Major applications for these brazing alloys are the joining of copper and brass heat exchangers for automotive and industrial applications. In some cases it is possible to replace expensive silver containing brazing alloys with VITROBRAZE copper and nickel alloys.



A micrograph of a tube-fin joint of a copper-based heat exchanger brazed with VITROBRAZE VZ2255

Advantages of VITROBRAZE

One reason for the superiority of VITROBRAZE products is their amorphous structure. Amorphous materials are compositionally much more uniform and they melt over a narrow temperature range under transient heating. This is a consequence of the shorter distances over which atoms of the different elements have to diffuse in order to form a uniform liquid phase. The resultant instant melting, and their superior flow characteristic, is only one of the important features of VITROBRAZE. The absence of the residual organic solvent bases evident in powder paste or tapes correspondingly eliminates soot formation and furnace fouling. The low level of gaseous impurities in VITROBRAZE, due to the specific characteristics of its production technology, is an attractive feature for vacuum furnace brazing.

A fully brazed exhaust gas recirculation cooler using VITROBRAZE amorphous brazing foils

VITROBRAZE nickel and iron based products have no limitation in shelf life. They are available as strip with a width from 2.5 mm to 200 mm and a thickness from 20 µm up to 50 µm. Preforms can be easily produced by using punch and die, cutting and slitting, photochemical etching and other methods. It is simple to use foils and preforms in automated production and assembling steps.

The use of foils and preforms reduces waste and enhances manufacturing efficiency. Drying and evaporation operations, which are required with powder or paste and tape forms are not necessary. The optimal amount of brazing material can be easily applied to the component, and in just one heating cycle VITROBRAZE creates uniform braze joints with an outstanding quality.

A plate heat exchanger using VITROBRAZE amorphous brazing foil preforms

PHYSICAL PROPERTIES OF VITROBRAZE ALLOYS

NICKEL BASED Nominal composition (wt. %) Specification Cross Reference Chart

VAC - Alloy	Ni	Fe	Cr	Mo	Si	B	P	DIN EN ISO 17672	AWS A5.8	AMS
VZ2111	Bal. (75.5)	4.2	13.0	–	4.5	2.8	–	1.)	1.)	1.)
VZ2120	Bal. (82.4)	3.0	7.0	–	4.5	3.1	–	Ni 620	BNi-2	4777
VZ2133	Bal. (92.4)	–	–	–	4.5	3.1	–	Ni 630	BNi-3	4778
VZ2150	Bal. (73.4)	–	18.2	–	7.3	1.15	–	2.)	2.)	2.)
VZ2152	Bal. (72.5)	–	19.0	–	7.25	1.25	–	Ni 660	BNi-5a	2.)
VZ2154	Bal. (76.4)	–	15.0	–	7.25	1.35	–	Ni 661	BNi-5b	–
VZ2170	Bal. (70.0)	–	21.0	–	0.5	0.5	8.0	–	–	–
VZ2177	Bal. (67.0)	–	25.0	–	1.5	0.5	6.0	–	–	–
VZ2190	Bal. (81.3)	–	15.0	–	–	3.7	–	Ni 612	BNi-9	–

1.) FOIL ALTERNATIVE TO NI 610, BNI-1A, AMS 4776 2.) FOIL ALTERNATIVE TO NI 650, BNI-5, AMS 4782

IRON-NICKEL BASED Nominal composition (wt. %)

VAC - Alloy	Fe	Ni	Cr	Mo	Cu	Si	B	P
VZ2106	35.0	Bal. (43.6)	11.0	1.5	1.0	6.4	1.5	–

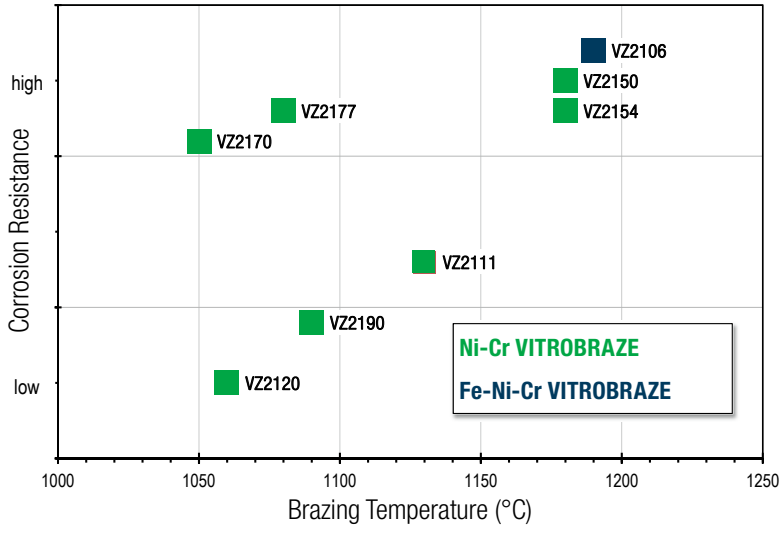
COPPER BASED Nominal composition (wt. %)

VAC - Alloy	Cu	Ni	Sn	P	Zn
VZ2250	Bal. (77.4)	7.0	9.3	6.3	–
VZ2255	Bal. (76.2)	7.0	9.3	6.5	1.0

SPECIFICATION CROSS REFERENCE CHART

VAC – Alloy VITROBRAZE	Solidus temperature °C (°F)	Liquidus temperature °C (°F)	Recommended brazing temperature °C (°F)	Amorphous density g/cm³ (lb/in³)
VZ2106	1044 (1910)	1154 (2110)	1170 – 1220 (2140 – 2230)	7.51 (0.271)
VZ2111	970 (1780)	1100 (2015)	1130 - 1200 (2065 - 2190)	7.73 (0.278)
VZ2120	970 (1780)	1025 (1875)	1030 - 1180 (1885 - 2155)	7.82 (0.283)
VZ2133	980 (1795)	1040 (1905)	1060 - 1180 (1940 - 2155)	7.96 (0.288)
VZ2150	1040 (1905)	1140 (2085)	1160 - 1200 (2120 - 2190)	7.62 (0.275)
VZ2152	1065 (1950)	1150 (2100)	1170 - 1200 (2140 - 2190)	7.60 (0.274)
VZ2154	1040 (1900)	1125 (2060)	1150 - 1200 (2100 - 2190)	7.65 (0.276)
VZ2170	880 (1610)	925 (1695)	1030 – 1080 (1880 – 1980)	7.70 (0.278)
VZ2177	945 (1740)	1040 (1930)	1050 – 1120 (1920 – 2050)	7.67 (0.277)
VZ2190	1055 (1930)	1070 (1960)	1090 - 1200 (1995 - 2190)	7.96 (0.288)
VZ2250	600 (1110)	630 (1160)	640 - 680 (1180 – 1260)	8.25 (0.297)
VZ2255	600 (1110)	630 (1160)	640 - 680 (1180 – 1260)	8.25 (0.297)

Comparison of the corrosion resistance of brazed VITROBRAZE / AISI 316 L joints towards exhaust gas condensate versus brazing temperature.



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