VDM Metals

VDM® Aluchrom Y Hf

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Material Data Sheet No. 4149

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VDM® Aluchrom Y Hf is a ferritic chrome steel alloyed with yttrium and hafnium. Due to the high content of aluminum and chrome, in combination with yttrium and hafnium, the alloy stands out for its good high-temperature resistance.

VDM® Aluchrom Y Hf is characterized by:

- very good isothermal and cyclical oxidation resistance,

Designations

Standard	Material designation
EN	(1.4767) (X8CrAl20-5)

Designations and standards in brackets show that some data from VDM Metals might be different.

Standards

Product form	ASTM	DIN
Strip	B603	1.7470

Table 1 – Designations and standards

Chemical composition

	Ni	Cr	Fe	C	S	N	Mn	Si	P	Al	Zr
Min.		19	Bal.							5.5	
Max.	0.3	22		0.05	0.005	0.01	0.5	0.5	0.03	6.5	0.07
Due to technical reasons the alloy may contain more elements then listed.											

Table 2 – Chemical composition (%) according to standard

Physical properties

Density	Melting range	
7,2 g/cm³ at 20 °C lb/ft³ at 69 °F	1.500 °C 2,732°F	The alloy is magnetic

Temperature		Specific heat capacity		Thermal conductivity		Electrical resistivity	Coefficient of thermal expansion	
°C	°F	$\frac{W}{m \cdot K}$	$\frac{Btu}{lb \cdot °F}$	$\frac{W}{m \cdot K}$	$\frac{Btu \cdot in}{sq.\ ft \cdot h \cdot °F}$	µΩ · cm	$\frac{10^{-6}}{K}$	$\frac{10^{-6}}{°F}$
30	86	490	0.117	9.8	5.66	140		
100	212			10.9	6.3	140	12.2	6.78
200	392			12.4	7.16	141	12.4	6.89
300	572			13.9	8.03	141	12.6	7.0
400	752	640	0.153	15.5	8.96	141	12.9	7.17
500	932			16.9	9.76	142	13.3	7.39
600	1,112			18.2	10.5	144	13.6	7.56
700	1,292			19.7	11.4	145	13.8	7.67
800	1,472			21.1	12.2	145	14.3	7.94
900	1,652			22.5	13.0	146	14.8	8.22
1,000	1,832	670	0.16					

Table 3 – Typical physical properties at room and elevated temperatures

Microstructural properties

VDM® Aluchrom Y Hf has a cubic body-centered crystal structure.

Mechanical properties

The following mechanical properties apply to VDM® Aluchrom Y Hf in the soft-annealed condition.

Temperature		Yield strength $R_{p\,0.2}$		Tensile strength R_m		Elongation A
°C	°F	MPa	ksi	MPa	ksi	%
20	68	510	74.0	650	94.3	15
600	1,112	185	26.8	190	27.6	75
800	1,472	55	7.98	60	8.7	80
1,000	1,832	25	3.63	30	4.35	25

Table 4 – Typical minimum mechanical short-term characteristics in the soft annealed condition

Corrosion resistance

VDM® Aluchrom Y Hf is a ferritic chrome steel with an addition of more than 5% aluminum, up to 0.1 % yttrium and up to 0.1% hafnium. The high aluminum concentration in combination with the precisely adjusted percentages of yttrium and hafnium permit its use under extreme conditions of up to 1,200°C (2,192 °F). This is made possible by the well-adhering Al_2O_3-layer.

Applications

VDM® Aluchrom Y Hf is foremost used as a carrier film in exhaust catalysts in the automotive industry and as a heating material for cooking plates/ceramic hobs.

Fabrication and heat treatment

In the specified dimensions, VDM® Aluchrom Y H is ideally suited for processing with the common industrial processing techniques. After use in temperatures above 1,000 °C (1,832 °F) and in the range between 400 °C (752 °F) and 550 °C (1,022 °F), cold embrittlement can occur.

Heating
It is important that the workpieces are clean and free of any contaminations before and during heat treatment. Sulfur, phosphorus, lead and other low-melting point metals can result in material damage during the heat treatment. This type of contamination is also contained in marking and temperature-indicating paints or pens, and also in lubricating grease, oils, fuels and similar materials. The sulfur content of fuels must be as low as possible. Natural gas should contain less than 0.1 wt.-% of sulfur. Heating oil with a maximum sulfur content of 0.5 wt.-% is also suitable. Electric furnaces are preferable for their precise temperature control and a lack of contaminations from fuels. The furnace temperature should be set between neutral and slightly oxidizing and it should not change between oxidizing and reducing. The workpieces must not come in direct contact with flames.

Hot forming
VDM® Aluchrom Y Hf should be hot-formed at a temperature range of between 1.050 and 850 °C (1,922 and 1,562 °F) with subsequent rapid cooling down in water or in air, whereby the temperature range from 560 to 400 °C (1,040 to 752 °F) must be passed through quickly. Heat treatment after hot forming is recommended in order to achieve optimal properties. Hot forming preferably takes place in 200 to 300°C (392 to 572 °F).

Cold forming
The workpieces should be in the annealed condition for cold forming. Intermediate annealing is necessary for major cold forming work. Oxidizing flat material can also be bent and cold formed. The internal bending diameter should be at least 3 x the sheet thickness.

Heat treatment
The annealing should be performed at temperatures above 800 °C (1,472 °F). Cooling down should be accelerated with water to achieve optimum properties. Thin strips can also be cooled rapidly in the air. The material must be placed in a furnace that has been heated up to the maximum annealing temperature before any heat treatment. For strips as the product form, the heat treatment can be performed in a continuous furnace at a speed and temperature that is adapted to the strip thickness. The cleanliness requirements listed under "Heating" must be observed.

Descaling and pickling
High-temperature alloys develop a protective oxide layer in service. Pre-oxidation can improve the oxidation resistance in higher temperatures. The necessity for descaling must therefore be checked when placing the order. Oxides of VDM® Aluchrom Y Hf and heat tint in the area around welds adhere more strongly than in stainless steels. Should descaling be required, grinding using extremely fine abrasive belts or grinding discs is recommended. If pickling is required, which is usually done in saltpeter-hydrofluoric acid mixtures, the oxide layers must be destroyed by abrasive blasting or fine grinding or they must be pre-treated in salt baths. Particular attention must be paid to the pickling time and temperature of the pickle.

Machining
VDM® Aluchrom Y Hf should preferably be processed in the heat treated condition. The processing parameters known for ferritic chrome steels must be used.

Welding information

Safety
The generally applicable safety recommendations, especially for avoiding dust and smoke exposure must be observed.

Welding information
Although the welding VDM® Aluchrom Y Hf is not generally recommended as the joining method, the material can be welded for many applications, e.g. using the TIG or laser technique. In addition, soldering can be an alternative to welding. For welding, the material should be in the annealed condition and be free of scale, grease or markings. During welding, the greatest measure of cleanliness must be ensured and draft air has to be avoided. For welding nickel alloys and special stainless steels, the following information should be taken into account:

Edge preparation
Welding seam preparation should preferably be carried out using mechanical methods through lathing, milling or planing. Abrasive waterjet cutting or plasma cutting is also possible. In the latter case, however, the cut edge (seam flank) must be cleanly reworked. Careful grinding without overheating is also permissible.

Welding parameters and influences
It must be ensured in the welding process that work is carried out using targeted heat application, low heat input and rapid heat extraction. The interpass temperature should not exceed 120 °C (248 °F). In principle, checking of welding parameters is necessary. Heat input Q can be calculated as follows:

Q =U x I x 60 / v x 1000 (kJ/cm)
U = arc voltage,
Volt I = welding current strength, Ampere v = welding speed, cm/min

Post-treatment
If the work is carried out in the optimal way, brushing directly after welding, meaning still in the warm condition, will result in the desired surface condition without additional pickling, i.e. heat tints can be removed without residues. Pickling, if required or specified, should generally be the last operation in the welding process. The information contained in the section entitled "Descaling and pickling" must be observed. Heat treatments are normally not required before or after welding.

Availability

VDM® Aluchrom Y Hf is available in the following semi-finished form:

Strip

Delivery condition: Cold rolled, heat treated, pickled or bright annealed

Thickness mm (in)	Width mm (in)	Coil-inside diameter mm (in)			
0,025-0,15 (0.000984-0.00591)	4-230 (0.157-9.06)	300 (11.8)	400 (15.7)	500 (19.7)	–
0,15-0.25 (0.00591-0.00984)	4-720 (0.157-28.3)	300 (11.8)	400 (15.7)	500 (19.7)	–
0,25-0,6 (0.00984-0.0236)	6-750 (0.236-29.5)	–	400 (15.7)	500 (19.7)	600 (23.6)
0,6-1,2 (0.0236 – 0.0472)	8-750 (0.315-29.5)	–	400 (15.7)	500 (19.7)	600 (23.6)

Rolled sheet – separated from the coil – are available in lengths from 250-4,000 mm (9.84 to 157.48 in).

Publications

The following technical literature has been published about the material VDM® Auchrom Y Hf:

J. Kloewer, A. Kolb-Telieps, U. Heubner, M. Brede: Effects of alloying elements and foil dimensions on the life time of thin Fe-Cr-Al foils in catalytic converters. CORROSION 1998, Paper No. 746, NACE International, San Diego, 1998.

J. Kloewer, A. Kolb-Telieps, B. Brede: Effect of aluminium and reactive elements on the oxidation behaviour of thin Fe-Cr-Al foils. Int. Conference MACC ‘97, Wuppertal 1997.

A. Kolb-Telieps, J. Kloewer, A. Heesemann, F. Faupel: High temperature corrosion resistant Fe-Cr-Al foils. HTCP Conference 2000, Hokkaido, Japan.

Legal Notice

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