

VDM® Aluchrom 4 18 Y HF

VDM® Aluchrom 4 18 Y Hf

VDM® Aluchrom 4 18 Y Hf is a high-temperature ferritic stainless steel alloyed with medium aluminum content and improved workability. Due to additions of yttrium and hafnium, the alloy possesses good high temperature resistance.

VDM® Aluchrom 4 18 Y is characterized by:

- good oxidation resistance under isothermal and cyclic conditions,
- good workability.

Designations and standards

Standard	Material designation
DIN EN	1.4737 – X6 CrAl 18-4

Table 1 – Designations and standards

Chemical composition

	Ni	Cr	Fe	C	S	Mn	Si	Al	Y	Zr	Hf	P	Cu
Min.		17.0	bal.					3.5					
Max.	0.5	19.0		0.08	0.03	0.5	0.6	5.0	0.15	0.15	0.15	0.04	0.5

Table 2 – Chemical composition (%)

Physical properties

Density	Melting range
7.3 g/cm ³ 0.264 lb/in ³	1,516 °C (Solidus) – 1,531 °C (Liquidus) 2,761 °F (Solidus) – 2,788 °F (Liquidus)

Temperature		Thermal conductivity		Electrical resistivity	Specific heat		Coefficient of thermal expansion	
°C	°F	$\frac{W}{m \cdot K}$	$\frac{Btu \cdot in}{sq. ft \cdot h \cdot ^\circ F}$	$\mu\Omega \cdot cm$	$\frac{J}{kg \cdot K}$	$\frac{Btu}{lb \cdot ^\circ F}$	$\frac{10^{-6}}{K}$	$\frac{10^{-6}}{^\circ F}$
20	68			122				
100	212	15.4	8.9	123	518	0.124	10.9	6.1
200	392	16.5	9.5	124	549	0.131	11.3	6.3
300	572	17.7	10.2	125	586	0.140	11.6	6.4
400	752	18.6	10.8	127	634	0.151	12.0	6.7
500	932	19.6	11.3	128	702	0.168	12.4	6.9
600	1,112	25.3	14.6	132	891	0.213	12.7	7.1
700	1,292	22.2	12.8	133	703	0.168	13.2	7.3
800	1,472	23.5	13.6	134	679	0.162	13.8	7.7
900	1,652	24.7	14.3	135	675	0.161	14.3	7.9
1,000	1,832	26.1	15.1	136	680	0.162	14.8	8.2

Table 3 – Typical physical properties at room and elevated temperatures.

Micostructural properties

VDM® Aluchrom 4 18 Y Hf has a body-centered-cubic structure.

Mechanical properties

	Yield strength R _{p 0.2}		Tensile strength R _m		Elongation A	Hardness (For information only)
	MPa	ksi	MPa	ksi	%	HV
Minimum ^{*)}	≥ 420	≥ 60.9	≥ 550	≥ 79.8	A ₅₀ ≥ 18 A ₅ ≥ 25	170 – 220
Typical values	480	69.6	600	87.0	22 (A ₅₀) 30 (A ₅)	

^{*)} Minimum mechanical properties in the soft-annealed condition for strip at room temperature

Table 4 –Mechanical properties for strip at room temperature.

Corrosion resistance

VDM® Aluchrom 4 18 YHf is a ferritic chromium steel with additions of about 4 % aluminum and up to 0.15 % yttrium and hafnium respectively. Due to the additions of yttrium and hafnium VDM® Aluchrom 4 18 YHf possesses a dense, well adhering Al₂O₃-layer, which ensure an excellent high temperature resistance (Figure 1) against oxidation even at the reduced aluminum content of about 4 %.

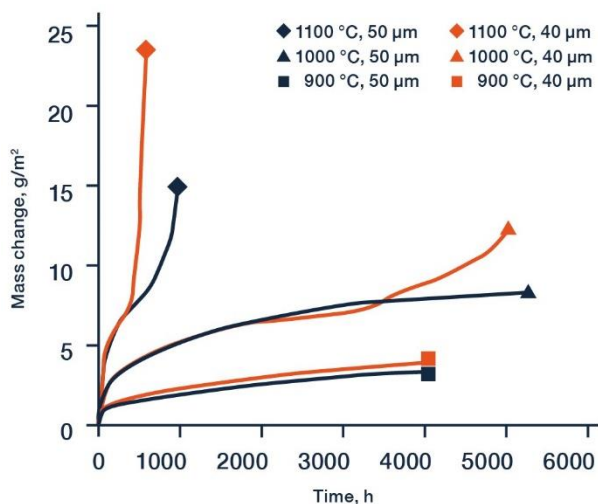


Figure 1 – Mass change during discontinuous oxidation tests (100 h cycles) of VDM® Aluchrom 4 18 YHf of 40 μm and 50 μm strip thickness at 900 °C, 1,000 °C and 1,100 °C in air as a function of time measured on samples simulating catalytic converters (typical values).

Applications

VDM® Aluchrom 4 18 YHf is used mainly as a metallic substrate for automotive catalytic converters. Other applications are heating elements and furnaces.

Fabrication and heat treatment

Due to the reduced aluminum content VDM® Aluchrom 4 18 YHf can easier be hot- and cold-worked and machined in comparison to VDM® Aluchrom YHf with 6 % aluminium. Cold brittleness may occur after use at temperatures exceeding 1000 °C and also after use at temperatures between 400 and 550 °C.

Heating

Production pieces must be clean and free from all kinds of contaminants before and during any heating operation. VDM® Aluchrom 4 18 YHf may become embrittled if heated in the presence of contaminants such as sulfur, phosphorus, lead and other low-melting-point metals. Sources of such contaminants include marking and temperature-indicating paints and crayons, lubricating grease, fluids, and fuels. Fuels must be as low in sulfur as possible. Natural gas should contain less than 0.1 wt.-% sulfur. Liquid fuels with a sulfur content not exceeding 0.5 wt.-% are suitable. Due to their close control of temperature and lack of contamination, thermal treatments in electric furnaces under vacuum or in an inert gas atmosphere are to be preferred. Treatments in an air atmosphere and alternatively in gas-fired furnaces are acceptable though, if contaminants are kept at low levels so that a neutral or slightly oxidizing furnace atmosphere is attained. A furnace atmosphere fluctuating between oxidizing and reducing conditions must be avoided as well as direct flame impingement on the metal.

Hot working

VDM® Aluchrom 4 18 YHf should be hot-worked in the temperature range 1050 to 850 °C (1920 to 1560 °F), followed by water quenching or rapid air cooling, in particular the temperature range 560 °C – 400 °C (1040 – 750 °F) should be passed through quickly. Hot bending is preferably carried out at 200 to 300 °C (390 to 570 °F). Temperatures in excess to 400 °C should be avoided.

Cold working

The material should be in the soft annealed condition. Intermediate annealing may be necessary with high degrees of cold forming.

Heat treatment

Soft annealing of VDM® Aluchrom 4 18 YHf should be carried out at temperatures above 800 °C (1470 °F). For optimum properties the material should be water quenched after annealing. Small dimensions can also be cooled down rapidly in air. For any thermal treatment operation the precautions concerning cleanliness mentioned earlier under 'Heating' must be observed.

Machining

VDM® Aluchrom 4 18 YHf should be machined preferably in the soft annealed condition.

Descaling and pickling

Oxides of VDM® Aluchrom 4 18 YHf and discoloration adjacent to welds are more adherent than on standard stainless steels. Grinding with very fine abrasive belts or discs is recommended. Care should be taken to prevent tarnishing.

Availability

VDM® Aluchrom 4 18 Hf is available in the following standard semi-finished forms:

Strip

Delivery condition: cold rolled, soft annealed and pickled or bright annealed²⁾

Thickness mm (in)	Width mm (in)	Coil – inside diameter mm (in)			
0.02 – ≤ 0.10 (0.0008 – ≤ 0.004)	4 – 200 ⁴⁾ (0.16 – 8 ⁴⁾)	300 (12)	400 (16)		
> 0.10 – ≤ 0.25 (> 0.004 – ≤ 0.01)	4 – < 720 ⁴⁾ (0.16 – 14 ⁴⁾)	300 (12)	400 (16)	500 (20)	
> 0.25 – ≤ 0.6 (> 0.01 – ≤ 0.024)	6 – < 750 (0.24 – 30)		400 (16)	500 (20)	600 (24)
> 0.60 – ≤ 1.0 (> 0.024 – ≤ 0.04)	8 – < 750 (0.32 – 30)		400 (16)	500 (20)	600 (24)
> 1.0 – ≤ 2.0 (> 0.04 – ≤ 0.08)	15 – < 750 (0.60 – 30)		400 (16)	500 (20)	600 (24)
> 2.0 – ≤ 3.0 ³⁾ – ≤ 3.5 ³⁾ (> 0.08 – ≤ 0.12 ³⁾ – ≤ 0.14 ³⁾)	25 – < 750 (1.00 – 30)		400 (16)	500 (20)	600 (24)

1) Cut-to-length available in lengths from 250 to 4,000 mm (10 to 158 in)

2) Maximum thickness: bright annealed – 3 mm (0.120 in)
cold rolled only – 3.5 mm (0.140 in)

3) Wider widths subject to special enquiry

4) Wider widths up to 730 mm (29 in) subject to special enquiry

Legal notice

29.07.2021

Publisher

VDM Metals International GmbH
Plettenberger Strasse 2
58791 Werdohl
Germany

Disclaimer

All information contained in this data sheet is based on the results of research and development work carried out by VDM Metals International GmbH and the data contained in the specifications and standards listed available at the time of printing. The information does not represent a guarantee of specific properties. VDM Metals reserves the right to change information without notice. All information contained in this data sheet is compiled to the best of our knowledge and is provided without liability. Deliveries and services are subject exclusively to the relevant contractual conditions and the General Terms and Conditions issued by VDM Metals. Use of the most up-to-date version of this data sheet is the responsibility of the customer.

VDM Metals International GmbH
Plettenberger Strasse 2
58791 Werdohl
Germany

Phone +49 (0)2392 55 0
vdm@vdm-metals.com
www.vdm-metals.com