Aluchrom Y

Material Data Sheet No. 8001
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Aluchrom Y is a ferritic chromium steel alloyed with yttrium and containing aluminium. It is distinguished by its excellent high-temperature strength as a result of its strongly adherent, ductile layer of aluminium oxide.

Aluchrom Y is characterised by:

- excellent cyclic and isothermal resistance to oxidation
- good heat resistance and creep properties
- reduced grain growth
- good long-time ductility.

Designation and standards

Country	Material designation	Specification			
		Chemical composition	Strip	Wire	Rod and bar
Germany	**(W.-Nr. ~ 1.4767)** CrAl 22 5 (Y)	see Table 2	up to 2.0 mm	0.03 – 12 mm	up to 12 mm

Chemical composition (%)

		Ni	Cr	Fe	C	Mn	Si	Al	Ti	Zr	Y		
Aluchrom Y	min	–	20.0	bal	0.01	–	–	5.0	0.01	0.01	0.05		
CrAl 22 5 (Y)	max	0.30	22.0		0.10	0.50	0.30	6.0	0.10	0.10	0.15		

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Physical properties
Typical physical properties at room and elevated temperatures.

Density	7.15 g/cm³	0.258 lb/in³
Melting temperature	approx. 1500 °C	2730 °F

Temperature T		Specific heat		Thermal conductivity		Electrical resistivity		Coefficient of thermal expansion between room temperature and T		Surface loading	
°C	°F	J/kg K	Btu / lb °F	W/mK	Btu in / ft² h °F	µ Ω cm	Ω circ mil / ft	10⁻⁶/K	10⁻⁶ / °F	W/dm²	W / in²
20	**68**	460	0.110	13.0	90						
93	**200**						836		6.4		
100	212					139		11.5			
200	392					140		11.9			
204	**400**						842		6.6		
300	572					140		12.1			
316	**600**						842		6.7		
400	752					141		12.3			
427	**800**						851		6.8		
500	932					142		12.6			
538	**1000**						854		7.1		
600	1112					143		13.0			
649	**1200**						863		7.4		
700	1292					144		13.5			
760	**1400**						871		7.6		
800	1472					145		13.8		250–300	
871	**1600**						876		7.8		12.2–14.5
900	1652					146		14.2		170–200	
982	**1800**						884		8.2		9.0–10.6
1000	1832					147		14.8		130–160	
1093	**2000**						884		8.6		6.5– 9.0
1100	2012	630	0.151			147		15.5		100–140	
1148	**2100**						884				5.8– 8.2
1200	2192					147				80–120	
1204	**2200**						884				5.1– 7.7
1260	**2300**						884				4.5– 6.0
1300	2372					147				60– 80	
1316	**2400**						884				3.7– 4.8

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Mechanical properties
The following properties at room and elevated temperatures are applicable to strip up to 2 mm thickness and wire up to 12 mm diameter in soft-annealed condition.

Temperature		0.2 % Yield strength		1.0 % Yield strength		Tensile strength Rm		Elongation A5
°C	°F	N/mm²	ksi	N/mm²	ksi	N/mm²	ksi	%
20	**68**	660	96	690	100	790	102	min 18
200	392	550		600		700		
204	**400**		80		87		101	
400	752	480		510		630		
427	**800**		67		70		87	
600	1112	260		300		360		
649	**1200**		26		32		39	
800	1472	40		45		100		
871	**1600**		3.9		4.2		8.7	
982	**1800**		1.9		1.9		4.2	
1000	1832	12		12		26		
1093	**2000**		1.2		1.2		2.2	
1100	2012	8		8		15		
1200	2192	4		4		10		

Table 4 – Typical short-time properties for wire.

20	**68**	520	75	560	81	670	97	min 20

Table 4a – Typical short-time properties for strip.

Temperature		Creep strength Rp 1.0/10³ h		Rp 1.0/10⁴ h		Creep-rupture strength Rm/10³ h		Rm/10⁴ h	
°C	°F	N/mm²	ksi	N/mm²	ksi	N/mm²	ksi	N/mm²	ksi
600	1112	40		34		60		50	
649	**1200**		3.5		3.0		6.8		5.5
700	1292	15.5		13		34		26.5	
760	**1400**		1.23		0.94		3.3		2.46
800	1472	6		4		17		12.2	
871	**1600**		0.44		0.22		1.67		1.16
900	1652	2.5		1		10		7	
982	**1800**		0.17		–		1.09		0.65
1000	1832	1				7		4	

Table 5 – Typical creep properties for wire.

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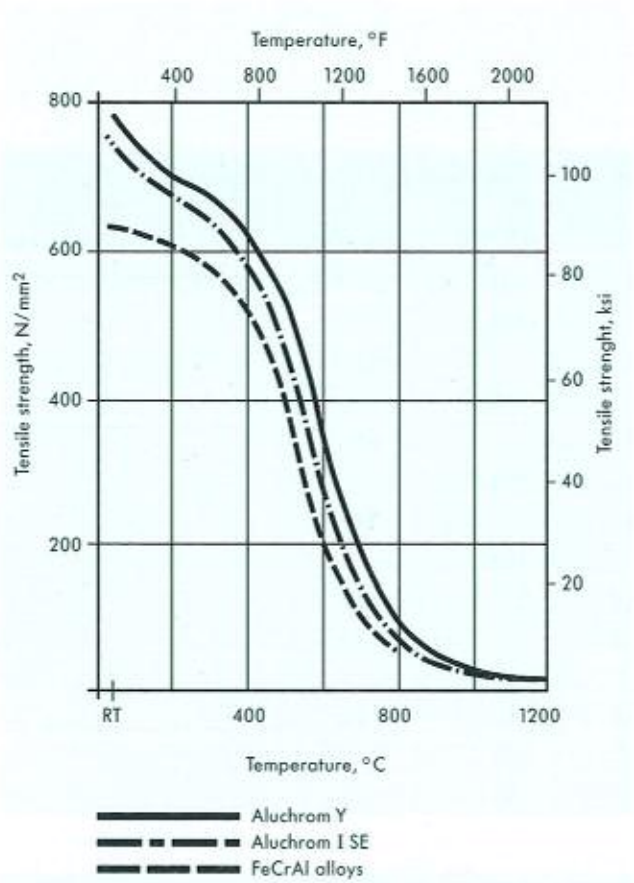

Fig. 1 – Comparison of typical tensile strengths in relation to temperature.

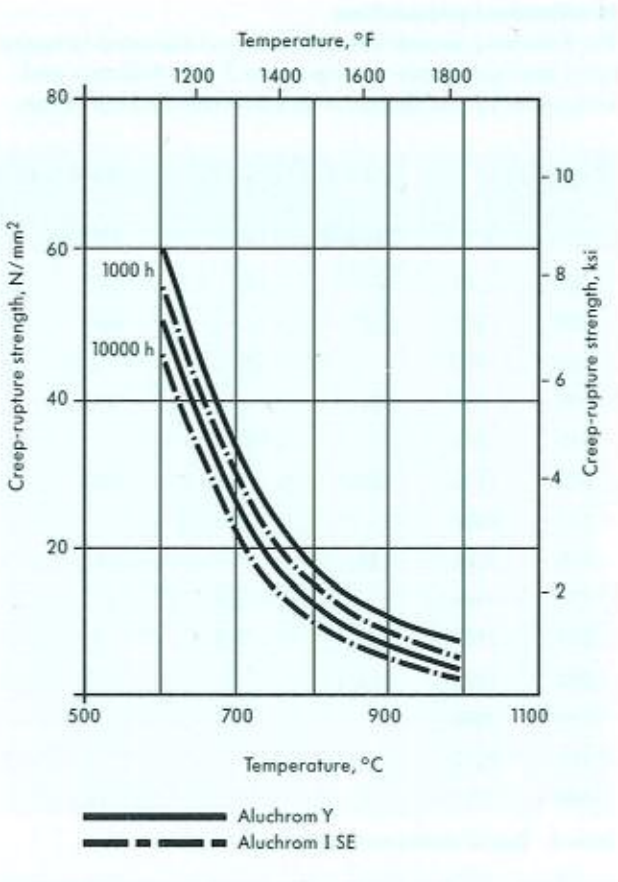

Fig. 2 – Comparison of typical creep-rupture strengths (10^3 and 10^4 hr) in relation to temperature.

Metallurgical structure
Aluchrom Y has a body-centred cubic structure.

Corrosion resistance
Aluchrom Y is a ferritic chromium steel alloyed with more than 5 % aluminium, with an addition of about 0.10 % yttrium.

Its excellent resistance to oxidation over the entire range of temperatures up to 1350 °C (2460 °F) results from its high aluminium content. The dense, well-adhering, stable layer of aluminium oxide is very resistant to spalling due to the addition of yttrium.

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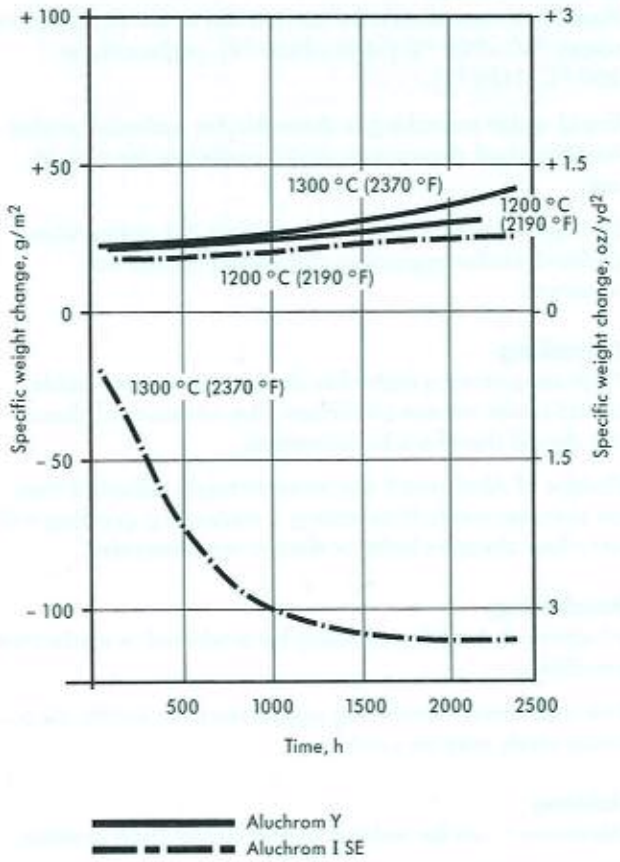

Abb. 3 – Specific weight change in relation to the temperature in cyclic testing in air.

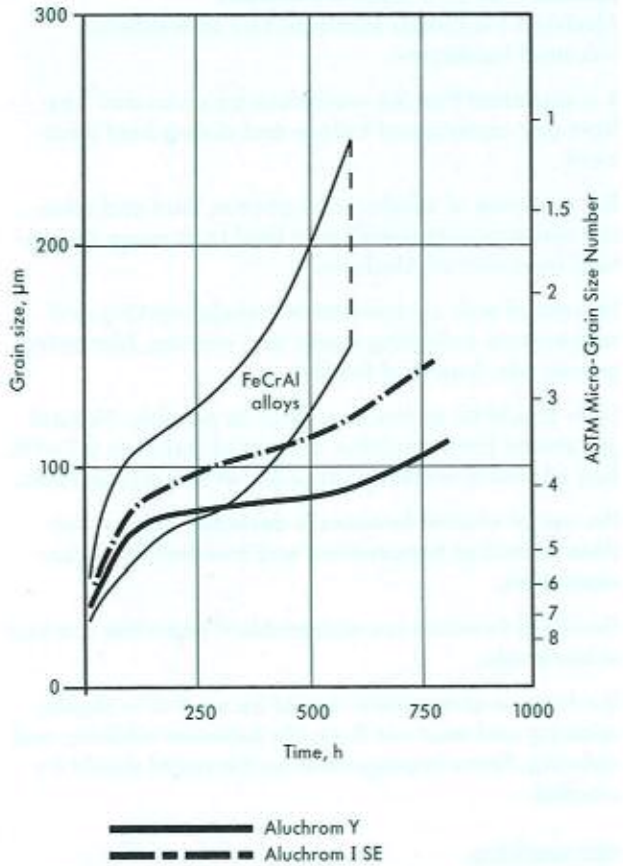

Fig. 4 – Grain growth of Aluchrom Y and Aluchrom I SE in comparison with conventional FeCrAl alloys at 1050 °C (1920 °F).

Typical applications

- High-temperature industrial furnaces with an element temperature not exceeding 1350 °C (2460 °F)
- Electric heating appliances (in thinner sizes)
- Ceran hotplates
- Tube elements
- Radiant heaters (quartz heaters), fans and toasters
- Metal supports for car exhaust gas catalytic converters
- Burner heads and covers

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Fabrication and heat treatment
Aluchrom Y is readily fabricated by conventional industrial techniques.

It is important that the workpiece be clean and free from any contaminant before and during heat treatment.

The presence of sulphur, phosphorus, lead and other low-melting-point metals may lead to damage during heat treatment of Aluchrom Y.

Sources of such contamination include marking and temperature-indicating paints and crayons, lubricating grease, oils, fuels and the like.

Fuels should be as low in sulphur as possible. Natural gas should have a sulphur content of less than 0.1 wt %. Fuel oil with a content of max 0.5 wt % is also suitable.

The use of electric furnaces is desirable due to their close control of temperature and freedom from contamination.

Gas-fired furnaces are acceptable if impurities are kept at low levels.

The furnace atmosphere should be neutral to slightly oxidising and must not fluctuate between oxidising and reducing. Flame impingement on the metal should be avoided.

Hot working
Aluchrom Y should be hot-worked in the range 1050 to 850 °C (1920 – 1560 °F), followed by rapid water quenching or air cooling; in particular, the temperature range 560 – 400 °C (1040 – 750 °F) should be passed through quickly.

The preferred temperature range for hot bending is 200 – 300 °C (390 – 570 °F). Temperatures in excess of 400 °C (750 °F) should be avoided.

Cold working
With cold working operations involving severe deformation, interstage annealing is necessary.

Renewed soft annealing is necessary after cold working operations involving 30 % or more deformation.

Heat treatment
Heat treatment should be carried out in the temperature range 760 – 900 °C (1400 – 1650 °F), preferably at 800 °C (1470 °F).

Rapid water quenching is desirable for optimum properties. For small dimensions, rapid cooling in air may be use.

During any heat treatment operation, the precautions outlined earlier regarding cleanliness should be observed.

Descaling
High-temperature materials develop protective oxide layers under service conditions. The necessity of descaling should therefore be examined.

Oxides of Aluchrom Y are more strongly adherent than on stainless steels. If descaling is necessary, grinding with very fine abrasive belts or discs is recommended.

Machining
Aluchrom Y should preferably be machined in oxide-free condition.

The well-known machining parameters for ferritic chromium steels may be used.

Joining
Aluchrom Y can be welded by the GTAW (TIG) process.

Prior to welding, the material should be in the soft-annealed condition and free from scale, grease or markings. A zone approximately 25 mm (1 in) wide on each side of the joint should be ground to bright metal. Any tarnishing can often be removed by brushing the joint while still warm. Painstaking attention to cleanliness is required during welding.

Low heat input and rapid heat dissipation should be ensured. The interpass temperature should not exceed 150 °C (300 °F).

Neither pre- nor post-weld heat treatment are necessary.

The use of a matching filler metal is recommended.

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Availability
Aluchrom Y is available in the following mill product forms:

Strip*
Condition:
cold rolled and bright annealed or oxidised

Thickness mm		Width mm	Coil I D mm			
0.04	≤ 0.10	30 – 120	100	300		
> 0.10	≤ 0.20	4 – 200		300	400	
> 0.20	≤ 0.25	4 – 400		300	400	
> 0.25	≤ 0.60	5 – 635		300	400	
> 0.60	≤ 1.0	8 – 635			400	500
> 1.0	– 2.0	15 – 635			400	500	600

inches		inches	inches			
0.0016	≤ 0.004	1.20 – 5	4	12		
> 0.004	≤ 0.008	0.16 – 8		12	16	
> 0.008	≤ 0.010	0.16 – 16		12	16	
> 0.010	≤ 0.024	0.20 – 25		12	16	
> 0.024	≤ 0.04	0.32 – 25			16	20
> 0.04	– 0.08	0.60 – 25			16	20	24

* cut-to length available in lengths from 500 to 3000 mm (20 to 120 in)

Wire
Conditions:
cold drawn,
bright annealed or annealed and oxidised

Dimensions:
0.03 – 12.0 mm (0.0012 – 0.48 in) diameter
in coils, pay-off packs, on spools and spiders

Technical publications
The following technical publications by Krupp VDM GmbH have appeared in connection with Aluchrom Y:

U. Brill
Metallic Materials for Automotive Exhaust Gas Catalyst Supports, International Conf. on Stainless Steels 1991, Chiba, Japan

U. Brill, G. Cloppenburg
Catalytic converter strip from Krupp VDM, an innovative product for invironment-friendly motor vehicles, Technische Mitteilungen Krupp (English edition) 1/1995, pp. 35–38

U. Brill, U. Heubner
Werkstoffe für Metallträger von Automobil-Abgas-katalysatoren, MTZ Motorentechnische Zeitschrift 49, Heft 9 (1988). pp. 365 – 368

U. Brill, U. Heubner
Werkstoffe für Metallträger von Automobil-Abgas-katalysatoren, Stahl im Automobilbau, international trade conference, Würzburg, 24-26 September 1990

Heating element and resistance alloys from VDM, Aluchrom Y, Krupp VDM GmbH, Publication N 5099, December 1989

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Please ask for the latest edition of this data sheet.

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