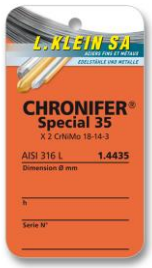


CHRONIFER® Special 35 P

1.4435/AISI 316L - Austenitic stainless steel for the watch exterior, TripleMelt, super clean, no δ ferrite, non magnetic

Features and Particularities

The CHRONIFER® Special 35 P is a TripleMelt premium grade austenitic stainless steel especially designed for components of the watch exterior as well as high demanding industrial items. This steel is VIM melted and ESR and VAR double remelted in furnaces of the latest generation. It can be characterized by its utmost cleanliness and microstructural fineness. It satisfies all polishing techniques at their most demanding levels. Its structural cleanliness favors its corrosion resistance, fatigue properties as well as the most severe IoT and Cloud controlled machining requirements by reducing the premature wear of the cutting tools.

Uses

The CHRONIFER® Special 35 P stainless steel is particularly well indicated for the production of components for the watch exterior, such as cases, bracelets parts as well as others high demanding industrial applications. It satisfies fully the high reliability and reproducibility requirements expected and needed for an automated an IoT cloud controlled productions.

Standards

Material number	1.4435
DIN - EN 10088-3	X2CrNiMo18-14-3
AFNOR	X2CrNiMo 18-13-3 (formerly Z3CND18-14-03)
AISI/SAE/ASTM	similar to 316L
JIS	SUS 316
NF S 94-090	X2CrNiMo18-14-3

Chemical composition (%wt)

C	Si	Mn	P	S	Cr	Ni	Mo	N	Cu	Fe
max.	0.30	1.15	max.	max.	17.5	13.5	2.50	max.	0.3	balance
0.030	0.45	1.65	0.010	0.002	19.0	15.0	3.00	0.11	0.50	

Melting Remelting

TripleMelt technology:
- VIM Vacuum Induction Melting
- ESR Electroslag Remelting
- VAR Vacuum Arc Remelting

Dimensions and Executions

- Bars ø 14-60 mm: hot rolled, solution annealed, shaved, ground, polished, UTS/Rm 500-700 MPa
- Bars ø 1-15 mm: solution annealed, ground, polished UTS/Rm 700-1000 MPa
- Bars ø 1-3 mm: HPM cold drawn, calibrated to tolerance h4-h5, 3m (2m) cut to length, angespitzt, angefasst, UTS/Rm = 750-1050 MPa
- Wires ø 1-2.5 mm: HPM cold drawn, calibrated to tolerance h5-h6, UTS/Rm = 800-950 MPa
- Rod wires ø >5.5 mm: solution annealed, shaved, skinpass UTS/Rm 570-700 MPa offered on „Open Source“ to transformators

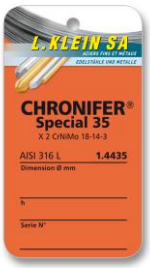
Availability

Standard dimensions on stock, see: Delivery program

Cutting conditions

Machinability:	relatively difficult, best in the cold worked condition
Cutting speed:	$V_c \approx 30$ - 40 m/min.
Lubricant-coolant:	individual choice

- The optimal cutting conditions depend on the machine tool, the cutting tools, the chip dimensions, the lubricant-cooling fluid, as well as the tolerances and surface the roughness to be achieved.



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Microstructural Cleanliness

according to EN 50602: K0 max. 2 (aimed K0 max.1)
ASTM E 112, alternative: < 1 A, B, C and D type of inclusion

Grain size

According to ASTM E47:
- hot rolled bars: ASTM Nr. ≥ 5
- cold drawn bars: ASTM Nr. ≥ 6
- cold drawn wires: ASTM Nr. ≥ 7

δ (Delta) Ferrite

The CHRONIFER® Special 35 P steel does not contain any δ (Delta) ferrite and is non magnetic.
According to the Schaeffler-DeLong diagram as revised by Otokumpu:
- Cr_{eq} = 1.5Si + Cr + Mo + 2Ti + 0.5Nb
- Ni_{eq} = 30(C + N) + 0.5Mn + Ni + 0.5(Cu + Co)
- $\%_{vol}$ Ferrite δ or Ferrite Number FN
  FN = ([1.375 {Cr_{eq} – 16} + 10] - Ni_{eq}) 2.586 FN
  Negative values indicate the absence of δ (Delta) ferrite

PREN

- PREN = %Cr + 3.3%Mo + 18%N
- Calculated basic parameters: min. 26.5 / max. 30.7

Forming

Warm, forging: 960 – 1100°C, quenching/rapid cooling
- In case the working temperature should fall below 960°C, it is advisable to submit the parts to a solution anneal

Cold: no limitations, See also p. 3, cold working strengthening

Solution anneal

Solution anneal: 1060-1080°C, quenching/fast cooling
- A minimum cold reduction of ≥ 10 – 15% is recommended to reduce the risk of a too fast and strong grain growth
- Temperature below 960°C should be avoided to eliminate the risk of precipitating the undesirable σ (Sigma) phase.
- The formation of σ (Sigma) phase leads to brittleness, reduction of the ductility and corrosion resistance.
  In such cases a solution anneal at 1060-1080°C is recommended.

Hardening

This steel cannot be hardened by heat treatment.

Strengthening

Cold working can only strengthen this steel. See page 3

Microstructures

Delivery condition, hot rolled: annealed austenite
Condition for machining and polishing: annealed or cold worked austenite,

Polishing

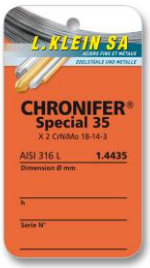
“Haut de gamme“ requirements:amenable
Electropolishing: amenable
- This steel does contain any ∂ (Delta) ferrite.
- In case of the presence of unwanted σ (Sigma) Phase which could jeopardize the aimed polishing quality, a solution anneal at 1060 -1080°C may restore it.

Welding

Feasible

Laser marking

A normal HAZ (Heat Affected Zone) due to the heating of the laser marking should not significantly affect the microstructure and its properties. More info



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Strengthening

The CHRONIFER® Special 35 P steel can be strengthened by cold working only. Figure 1 shows the cold work strengthening curves of the UTS and $YS_{0.2\%}$ and of the 10^7 cycles fatigue limit in alternate rotating bending fatigue, as function of the cold reduction. Figure 2 shows the corresponding Wohler curve.

Figure 1
Strengthening curves UTS and $Y_{0.2\%}$ curves Fatigue limit curve at 10^7 cycles

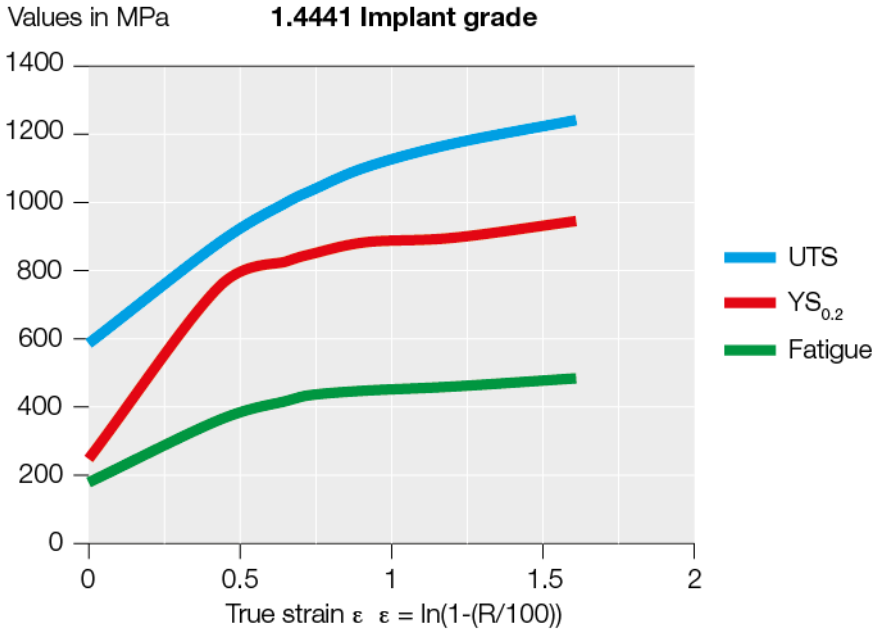
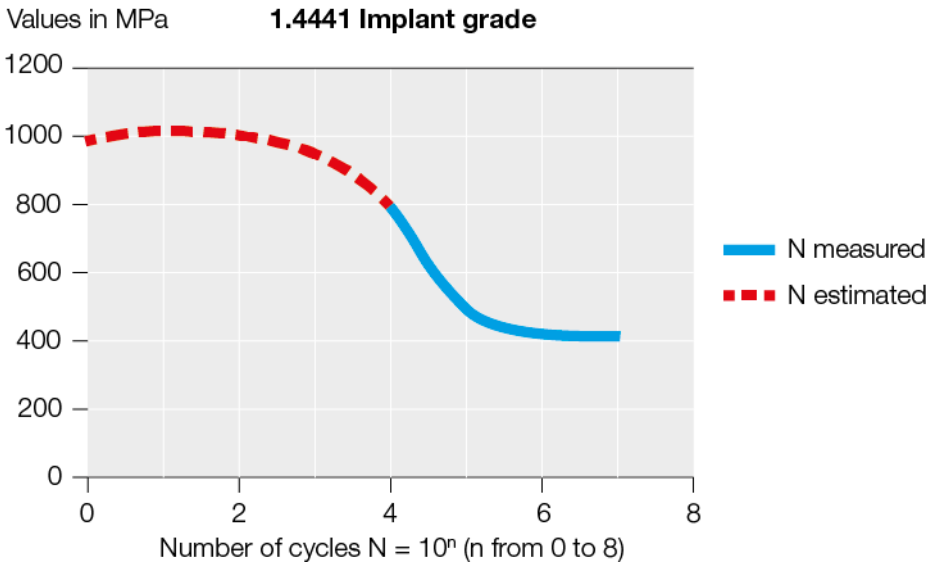


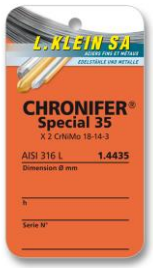
Figure 2
Wöhler curve (Fatigue limit)



Basic parameters

The basic benchmark parameters of the CHRONIFER® Special 35 P are:

- Cr_{eq}: <21.5
- Ni_{eq}: >18.0
- Cr_{eq}/Ni_{eq}: ≤1.16
- ∂ (Delta) ferrite: -2.2
- PREN: ≥27



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Surface oxidation

The oxides formed by thermal oxidation must be eliminated either mechanically or chemically.

- The presence of colored oxides or oxide scales on the surface can strongly reduce the corrosion resistance.

Pickling - Passivation

The procedures and products used to pickle and passivize this steel should be adapted to the requirements of austenitic stainless steels. More info

- Potential "Flash back" reactions can be avoided if the processed products are pickled before passivation.
- A passivation treatment is not necessary after eletropolishing.

Corrosion resistance

- Optimal surface condition: clean, polished and passivated.
- The various corrosion resistances of the CHRONIFER Special 35 P steel in the mediums prevailing for components for the watch exterior, are given below:

Corrosion type	Condition	Corrosion susceptibility
Pitting corrosion	all	Unaltered
Spray salt	all	Unaltered
Sea water	all	Unaltered
Stress corrosion cracking	Annealed	Not susceptible
	Cold worked ≤ 63% ε=1	Generally not susceptible either mechanically or
	In some circumstances a low temperature 250-300°C/1h stress relief treatment can be made preventively.	

Galvanic corrosion

- The CHRONIFER® Special 35 P steel is more noble than many metals including current 18/8 stainless steels.
- The electrolyte and the metals of an assembly may form a galvanic corrosion cell, which ultimately could lead to galvanic corrosion.

Elementary precautions

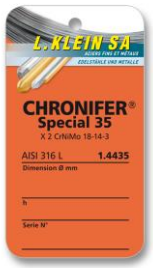
- The simplest and easiest precautions are always to keep the parts clean, free of working residues, polished, and correctly dried.
- Use only chloride free disinfection solutions, cleaning and washing solutions and products. More Info

Magnetism

The CHRONIFER® Special 35 P steel grade is not ferromagnetic.
Relative permeability: max 1.003

- No evidence of the presence of ∂ (Delta) ferrite by „Ferritoscope" check or metallographic examination at 100X.
- A strong plastic deformation i.e. à ε = 1 (≈ 63% cold reduction) does not lead to the formation of ferromagnetic α (Alpha) martensite.

Magnetism: More info



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Physical properties

Properties	Unit	Temperature (°C)				
		20	200	300	400	500
Density	g cm^{-3}	7.95				
Young modulus E	GPa	186.4				
Poisson coefficient		0.29				
Electrical resistance	$\Omega.mm^2.m^{-1}$	0.74				
Thermal expansion	m m^{-1} K^{-1} 10^{-6}	20–100°C 16.5	20–200°C 17.5	20–300°C 17.5	20–400°C 18.5	20–500°C 19
Thermal conductivity	$W.m^{-1}.K^{-1}$	16			15.2	
Specific heat	$J.kg^{-1}.K^{-1}$	500				
Melting range	°C	1370-1400 does not form ∂ (Delta) ferrite				
Magnetism	Non ferromagnetic					
Relative permeability	μr ≤1.003					

Disclaimer: The information and data of this informative “Data sheet“ are indicative only. They are not use instructions. The users must define and endorse them in each case.

Modifications will not be adjusted automatically.
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