



CHRONIFER® Special KL

1.4427 So/AISI 316L

Free machining austenitic stainless steel with limited S-addition

Features and Particularities

This 316L steel has a hybrid composition between the 1.4404 and 1.4435 Grades. Its Cr and Mo contents are these of the 1.4404 Grade and Ni content similar to the 1.4435 Grade. Its S addition to improve its machinability is limited to 0.10-0.14%. It exhibits mechanical properties similar to those of the 1.4404 Grade. But its S content lowers its pitting corrosion resistance. The CHRONIFER® special KL austenitic stainless steel cannot be thermally hardened. But it can be strengthened by cold working, although its S-content can somewhat restrict it. It may exhibit traces of ferromagnetic δ (Delta) Ferrite and of α (Alpha) Martensite in the strongly cold worked condition. It can be welded, although the presence of MnS inclusions requires additional attention. Its Polishing capabilities are limited as it cannot be mirror polished.

Uses

The main applications of this CHRONIFER® Special KL austenitic stainless steel are components for watch movements and the watch exterior.

Standards

Material number	1.4427 So
EN	≈ X12CrNiMoS18-11
DIN	≈ X12CrNiMoS18-11
AFNOR	≈ X12CrNiMoS18-11 (formerly Z 3 CNDF 17-13)
AISI/SAE	316L (+S)
JIS	SUS 316 F

Chemical composition (%wt.)

C	Si	Mn	P	S	Cr	Ni	Mo	Fe
max.	max.	max.	max.	0.10	16.5	12.0	2.00	Balance
0.030	1.00	2.00	0.045	0.14	18.5	14.0	2.50	

Dimensions and Tolerances and

Standard: Bars 3 m (+50/0 mm), coils for Escomatic
 Strength UTS: 650-950 MPa
 • Bars $\varnothing < 0.8-18$ mm: ISO h8
 • Bars $\varnothing \geq 2.00$ mm: ISO h6 (h7)
 • Wires $0.80 < \varnothing < 3.00$ mm: ISO fg7, coils for Escomatic
 • Out of roundness max: 1/2 Diameter tolerance
 Other tolerances on request

Executions

Standard: Bars 3 m (+50/0 mm), coils for Escomatic
 • Bars $\varnothing \geq 2.00$ mm: cold drawn, ground, polished, Ra (N5)
 Bar ends: pointed and chamfered°
 • Bars < 2.00 mm: Surface condition: cold drawn
 • Wires $\varnothing < \text{max. } 3.00$ mm: Surface condition: cold drawn, coils for Escomatic
 Other executions on request

Availability

Standard dimensions on stock: see: [Delivery program](#)

Cutting conditions

Machinability: Relatively difficult
 Best in the cold worked condition
 Cutting speed: $V_c \approx 25 - 40$ 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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Forming	<p>Warm, forging: 960 – 1100°C, quenching/rapid cooling</p> <ul style="list-style-type: none"> In case the working temperature should fall below 900°C, it is advisable to submit the parts to a solution anneal <p>Cold: no limitations, See also Figure 1 page 3, strengthening by cold working</p>
Solution anneal	<p>1060-1080°C/quenching or rapid cooling</p> <ul style="list-style-type: none"> A minimum cold reduction of ≥ 10 – 15% is recommended to reduce the risk of a too fast and strong grain growth The temperature range 450-650°C should be avoided to eliminate the risk of sensitization or formation of σ (Sigma) phase. See Figure 2 TTS curves, page 3 The sensitization and the formation of σ (Sigma) phase lead to brittleness, reduction of the ductility and corrosion resistance. <p>In such cases a solution anneal at 1060-1080°C is recommended.</p>
Hardening Strengthening	<ul style="list-style-type: none"> The CHRONIFER[®] special KL steel cannot be thermally hardened. This steel can be strengthened by cold deformation only. See Figure 1, page 3.
Microstructures	<p>Delivery condition, hot rolled: Austenite, annealed</p> <p>For machining and polishing: Austenite, annealed or cold worked</p>
Welding	<p>Feasible, but the numerous MnS inclusions may render the welding process more difficult.</p>
Laser marking	<ul style="list-style-type: none"> The numerous MnS inclusions may impair the laser marking. The HAZ Zone (Heat Affected Zone) of a normal laser marking should not significantly influence its local microstructure. More info
Surface oxidation	<p>A thermal oxidation forms colored oxides or scaling on the surface. These must be eliminated, is it chemically by pickling or by mechanical means like grinding.</p> <ul style="list-style-type: none"> Colored surface oxidation and/or scaling can massively reduce the corrosion resistance.
Pickling - Passivation	<p>The pickling and passivation processes and the products used therefore, should always be adapted to the requirements of the pickling and passivation of austenitic stainless steels. More info.</p> <ul style="list-style-type: none"> Potential “Flash back“ reactions staining the surface can always be avoided by applying a pickling process prior to passivation. An additional passivation treatment is not needed after electro polishing.
PREN	<ul style="list-style-type: none"> Because of the numerous MnS inclusions contained in this steel, the computed PREN (Pitting Resistance Equivalent Number) indice is of no practical significance.
Elementary precautions	<ul style="list-style-type: none"> The most elementary protection is to always keep the surfaces very clean, polished and passivized. The parts should always be very well cleaned (no usage residual) and dried. Only use adapted chlorine free disinfection, cleaning and washing products.



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Figure 1
Strengthening
by cold working

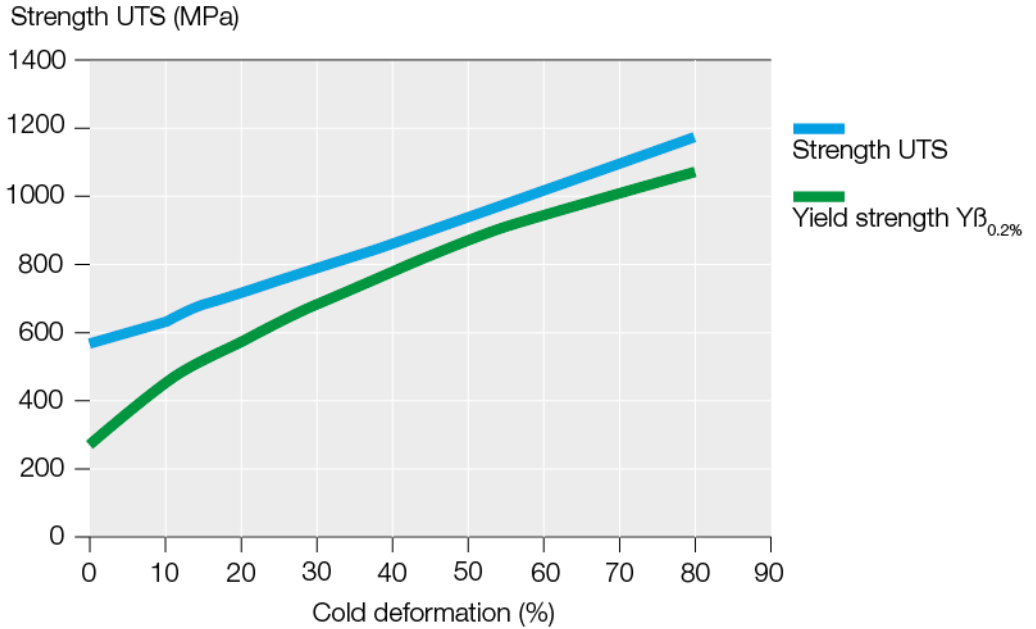
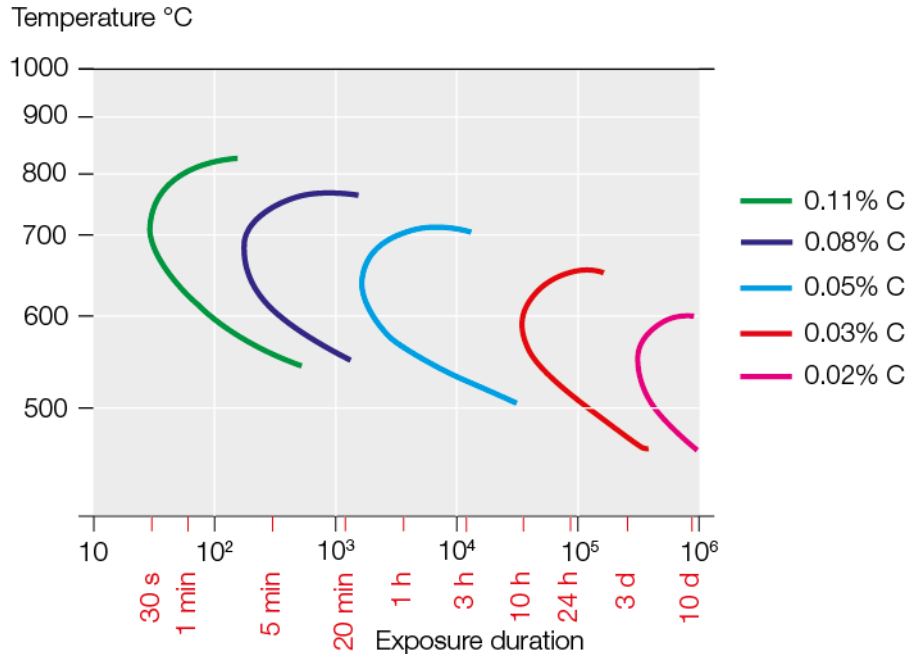
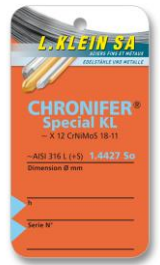


Figure 2
Sensitization
TTS curves



Limitations

- Figure 2 shows that this steel can be sensitized by long exposures in the temperature range of 450 to 650°C. It leads to the precipitation of carbides causing brittleness and intergranular corrosion.
- The intergranular carbides precipitated at the grain boundaries will be etched in relief by electro polishing.



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Corrosion resistance

- Optimal surface condition: very clean, polished and passivated.
- Table 1 below gives the indicative corrosion resistance of the CHRONIFER® Special KL steel in the usual mediums prevailing for components of the watch exterior.

[More info.](#)

Table 1
Indicative corrosion resistance

Type of corrosion	Condition	Corrosion susceptibility
Pitting corrosion	all	susceptible
Salt spraying test	all	susceptible
Seawater	all	susceptible
Stress corrosion	annealed	resistant
	cold deformed ≤ 63% ε=1	in general not susceptible
	A stress relieving treatment of max. 300°C/1h can Preventively be made.	

Magnetism

The CHRONIFER Special KL austenitic stainless steel can possibly exhibit traces of ferromagnetism due to:

A. δ (Delta) Ferrite:

- This steel may contain traces of δ (Delta) Ferrite. In those cases, its magnetic relative permeability μ_r in the annealed condition is >1.003.

B. α (Alpha) martensite formed by cold deformation:

- This steel can develop ferromagnetic α (Alpha) martensite during cold deformation. In this is the case, its relative permeability μ_r may increase to >1.05.

[More info.](#)

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	Ω.mm ² .m ⁻¹	0.74				
Thermal expansion	m m ⁻¹ K ⁻¹ 10 ⁻⁶	20-100°C	20-200°C	20-300°C	20-400°C	20-500°C
		16.5	17.5	17.5	18.5	19
Thermal conductivity	W.m ⁻¹ .K ⁻¹	16			15.2	
Specific heat	J.kg ⁻¹ .K ⁻¹	500				
Melting range	°C	1370-1400				
Magnetism annealed	Traces of δ (Delta) Ferrite Relative permeability: $\mu_r \geq 1.003$					
Magnetism cold worked	Traces of δ (Delta) Ferrite + ferromagnetic α (Alpha) Martensite Relative permeability: $\mu_r \geq 1.00$					

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.