



CHRONIFER® 108

UNS S29108 – Nickel free austenitic stainless steel for implants

Features and Peculiarities

The CHRONIFER 108 steel is the nickel free austenitic stainless steel “BioDur® 108 Alloy” of Carpenter. The substitution of Ni with Mn and a high N content permits to keep its microstructure fully austenitic in all conditions. The PESR (Pressure-ESR) remelting ensures its fine and clean microstructure as well as its reproducible fine microstructural properties. This steel is quite tough. It exhibits mechanical properties, fatigue properties and corrosion resistance superior to these of the 316L stainless steel grade satisfying the requirements of the ASTM F138 Standard. This steel is free of δ (Delta) ferrite and stays non-ferromagnetic in all its conditions. The low S content warrants it a good pitting corrosion resistance.

Uses

The CHRONIFER 108 steel is suitable for applications requiring both a high strength combined with a high corrosion resistance. These properties indicate it for regular bone surgery implants and for joint replacement prosthesis and implants. Its particularly high toughness is of interest for special uses. Its high mechanical properties, fatigue resistance, corrosion resistance and its non allergenic properties legitimate this steel as the material of choice for medical, surgical and dental instruments, orthodontic applications, components for the watch exterior and for hypoallergenic jewelry, ornament and decoration items.

Standards

ASTM	F-2229 (Implant quality)
EN/DIN	(~X4CrNiMoN 23-21-1)
UNS	S29108

Chemical composition (%wt)

C	Si	Mn	P	S	Cr	Ni	Mo	N	Cu	Fe
max.	max.	21.0	max.	max.	19.00	max.	0.50	0.90	0.25	balance
0.08	0.75	24.00	0.030	0.010	23.00	0.10	1.50			

Dimensions and Executions

- Bars $\varnothing \geq 2.00$ mm: ISO h6 (h8)
 - Wires ≥ 0.80 mm: ISO fg7, coils for Escomatic
 - Out of roundness max.: $\frac{1}{2}$ diameter tolerance
- Other tolerances and executions on request

Delivery condition

Standard: bars 3 m (+50/0 mm), coils for Escomatic

- Bars: $\varnothing \geq 2.00$ mm: cold drawn, ground, polished, Ra max. 0.4 μ m (N5)
Pointed and chamfered

Mechanical properties

- | | | | | |
|----------|--------------------|--------------|-----------------------------|----------------------------------|
| ● Bars: | Condition annealed | Rm (MPa) 970 | R _{0.2%} (MPa) 600 | A ₅₀ mm (%) ≤ 48 |
| ● Wires: | cold drawn | 970-2200 | 600-1800 | 38-3 |

Availability

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

Machining

- The CHRONIFER 108 steel is particularly tough. Consequently its machining requires (very!) stiff machine tools, tool fixtures and cutting tools.
- Machining: relatively difficult
somewhat easier in the cold deformed condition
- Cutting speed: $V_c \approx 20 - 25$ 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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Cleanliness	According to:	ASTM 45, Method A			
	Designation:	A	B	C	D
	Type:	Sulfides	Al Oxides	Silicates	Globular
	thin	≤ 1.5	≤ 2.5	≤ 2.5	≤ 2.5
	thick	≤ 1.5	≤ 1.5	≤ 1.5	≤ 1.5

δ (Delta) ferrite The CHRONIFER 108 steel is free of δ (Delta) ferrite. It is non-magnetic.

Forming

Warm: 1040 – 1150°C/rapid cooling by quenching

- Annealing after forging is recommended
- The temperature range 980-810°C should be avoided, because of a potential precipitation of Cr₂N that affecting negatively the corrosion resistance and the ductility.

Cold: no limitations
strong strengthening by cold deformation

Annealing 1050-1150°C/rapid cooling by quenching

- The typical annealing is 1065°C/1h/ rapid cooling by quenching
- The temperature range 980-810°C should be avoided, because of a potential precipitation of Cr₂N that affect negatively both the corrosion resistance and the ductility.

Protective atmosphere

- Pure Argon grade only permit to ban the formation of a ferromagnetic layer on the surfaces of the heat-treated items. This layer must be removed, eliminated.
- The danger of denitrification proscribes the heat treatment in vacuum.

Hardening Cold forming

- The CHRONIFER 108 steel cannot be hardened by heat treatment.
- The CHRONIFER 108 steel can be hardened by cold working only.

Microstructures

Delivery condition, warm rolled:	Austenite, annealed
For machining and polishing:	Austenite, annealed or cold deformed

Polishing

Mirror:	adapted
Electrolytic:	adapted

Marking

- The Laser marking of the CHRONIFER 108 steel can lead to a denitrification of the HAZ (Heat Affected Zone) laser marked dots. A Nitrogen loss alters negatively the corrosion resistance, mechanical properties and fatigue resistance of the laser marked dots and of their HAZ.

δ (Delta) ferrite

- The CHRONIFER 108 steel is free of δ (Delta) ferrite.

Magnetism

- The CHRONIFER 108 steel is non-magnetic.

**Table 1
Corrosion resistance**

Medium	Corrosion resistance	Medium	Corrosion resistance
Seawater	average	Salt spray	excellent
Humidity	excellent	Nitric acid	good

- The corrosion resistance is function of the temperature, concentration, pH, aeration, rapidity, cracks, surface condition and coating, stresses, metallurgical condition, contact with other metals.



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Figure 1
Cold deformation
hardening
UTS/Rm and $YS_{0.2}/R_{0.2}$

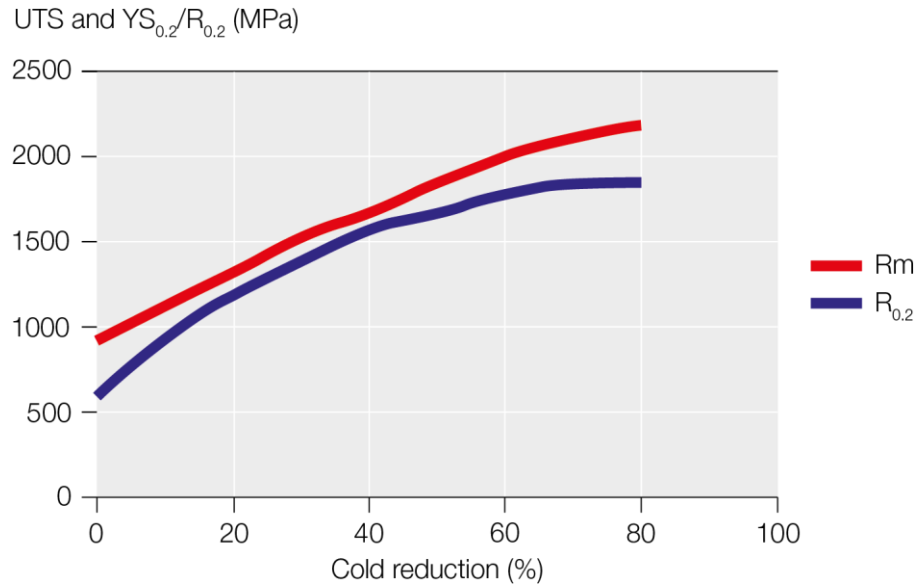
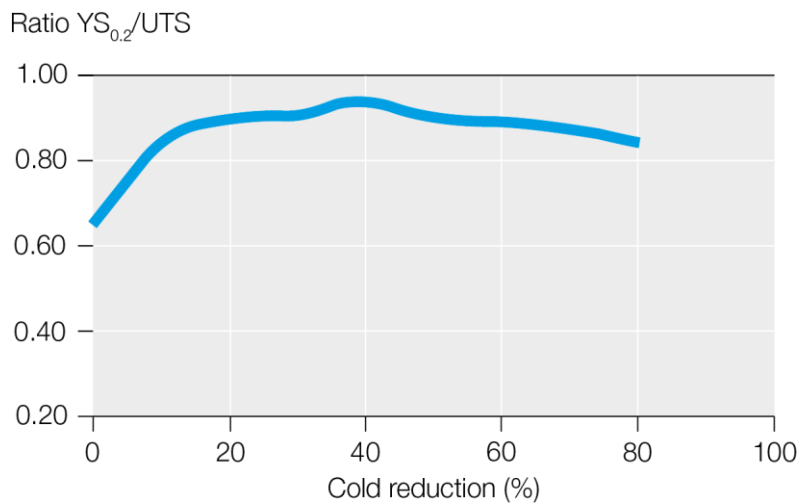


Figure 2
Cold deformation
hardening
Ratio $YS_{0.2}/UTS$



Welding

- The welding of the CHRONIFER 108 steel cannot be made because of the denitrication of the welded joints. The corrosion resistance and the mechanical properties are strongly negatively affected.

Pickling

Thermal oxidation builds up oxides layers that reduce the corrosion resistance. These layers must be totally eliminated either mechanically or chemically by pickling.

- Scale residuals or colored oxidized surfaces affect strongly negatively the corrosion resistance.
- The passivation can alone not replace pickling because of the danger of “flash back” reactions tarnishing the surface. Both operations are complementary.
- The appropriateness of the processes and products for pickling and passivation treatments must fulfill the specific minimum requirements of the CHRONIFER 108 steel.



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Figure 3
Rotating bending
fatigue strength

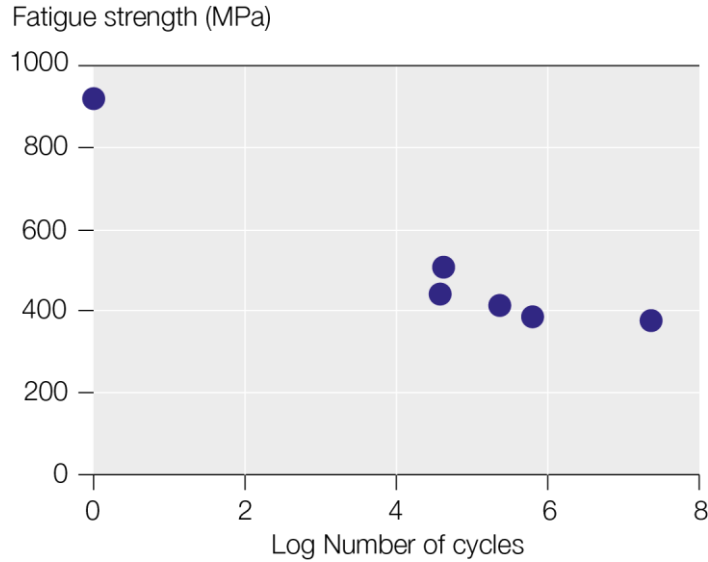
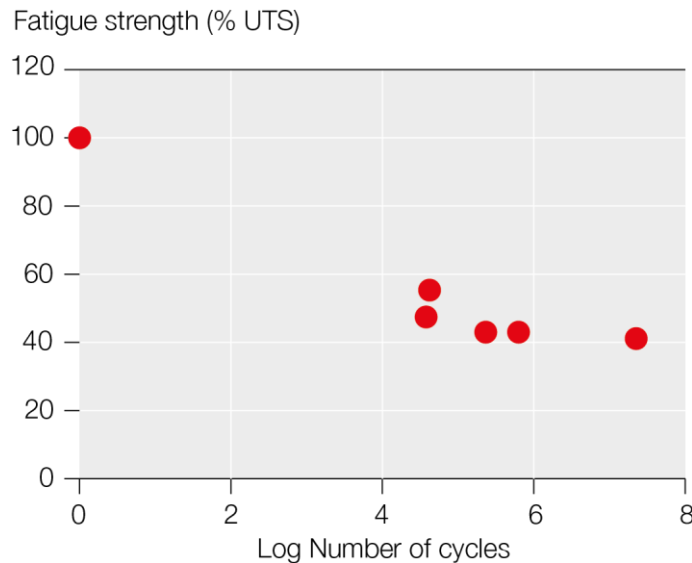


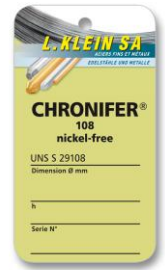
Figure 4
Rotating bending
fatigue strength
Ratio $YS_{0.2}/R_{0.2}/$
 UTS/R_m



- The Figures 3 and 4 show the fatigue strength of rotating bending fatigue tests and the ratio UTS/R_m in function of the number of bending cycles. The reference UTS/R_m strength is 913 MPa. It corresponds to the indicative strength of CHRONIFER 108 steel for prosthesis for joint replacement.

Biocompatibility

- The CHRONIFER 108 alloy is biocompatible and non-allergenic.



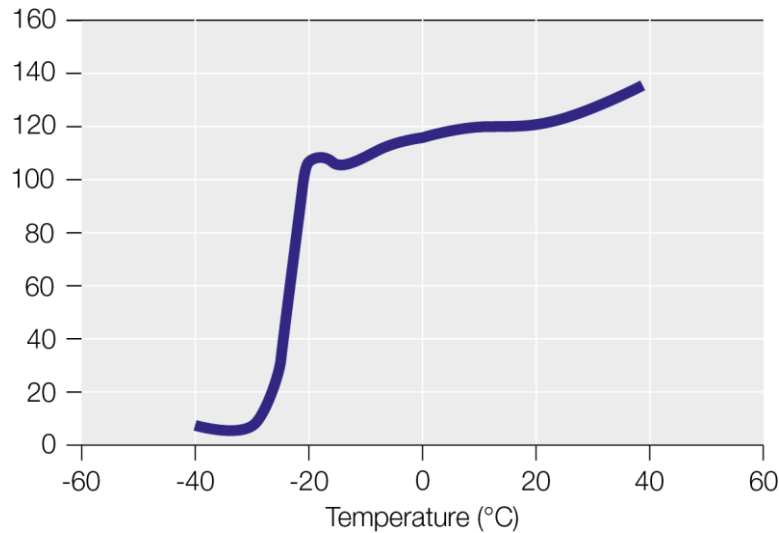
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Figure 5
V notched VCN
Charpy tests

Transition temperature
ductile-brittle

VCN Impact test (J)



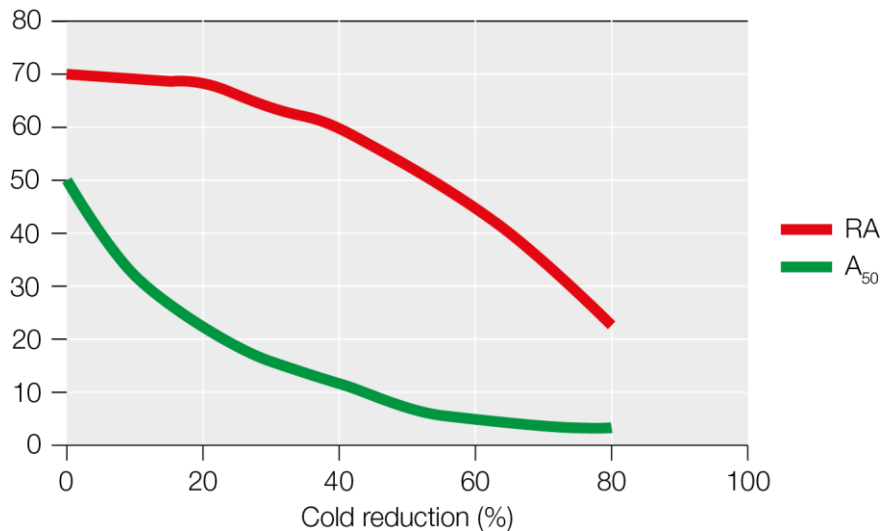
Operating temperature

- As shown by Figure 5 the CHRONIFER 108 steel has a ductile-brittle transition temperature of typically -20°C. Consequently, a safe permanent use must take it into account.

Figure 6
Ductility

Elongation $A_{50\text{ mm}}$
and
Reduction of area RA

Elongation A_{50} and RA



Elementary precautions

- The simplest precaution and protection is always keep the surfaces constantly very clean, fine polished and passivated.
- The instruments must preferably be dismantled and as quickly as feasibly as possible be cleaned (tolerance zero for residuals), well-rinsed and dried without water stain marks.
- Use appropriate chlorine free disinfection, cleaning and washing products.



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Passivation

- “Flash back“ reactions can always be totally avoided by making a pickling before the passivation treatment. [More info](#)
- Passivation is not necessary after electro-polishing.

Table 2
Physical properties

Properties	Unit	Temperature (°C)				
		20	200	300	400	500
Density	g.cm ⁻³	7.65				
Young modulus E	GPa	204				
Poisson coefficient		0.30				
Relative magnetic permeability	μr	max. 1.01				
Magnetism	non-magnetic					

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.