CHRONIFER® M-4021

Hardenable martensitic stainless steel

Main features and characteristics

The low C content of this steel favors in the hardened, fine polished and passivized condition, favors its corrosion resistance in chloride free solutions like soap, solvents and organic solutions. Its general corrosion resistance is better than this of the CHRONIFER® M13 (1.4034) grade, and especially this of the CHRONIFER® Labor M-13 (1.4035) steel grade.

Uses

This steel fulfills satisfactorily the requirements for medical, surgical and dental instruments.

Applicable standards

Material number	1.4021
ISO	7153-1 (B)
EN 10088-3	X20Cr13
DIN / AFNOR	X20Cr13
AISI/SAE/ASTM	AISI 420 and 420A, ASTM F899, A276, A959
NF	S 94-090
JIS	SUS 420 J1
UNS	S 42000

Chemical composition (%wt)

C	Si	Mn	P	S	Cr	Ni	Fe
0.16	max.	max.	max.	max.	12.00	max.	balance
0.25	1.00	1.00	0.04	0.03	14.00	1.00	

Dimensions and tolerances

- Bars Ø < 2.00 mm: ISO h8 (h7)
- Bars Ø ≥ 2.00 mm: ISO h6 (h7)
- Wires Ø ≥ 0.80 mm: ISO fg7, coils for Escomatic
- Out of roundness: max ½ of tolerance

Other tolerances on request

Executions and Delivery conditions

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

- Bars Ø ≥ 2.00 mm: cold drawn, ground, polished, max Ra 0.4 µm (N5)
  eddy-current check according to EN10277-1, Table 1
  end of bars: pointed and chamfered,
- Bars Ø < 2.00 mm: surface condition: cold drawn execution
- Wires Ø < 6.00 mm: coils for Escomatic

Other executions on request

Availability

Dimensions on stock, see: Sale program

Mechanical properties

Standard delivery condition: UTS strength: function of the diameter

Ø < 4.50 mm:	725 – 875 MPa
Ø ≥ 4.50 mm:	heat-treated QT 700 and cold drawn 600 – 800 MPa
Ø ≥ 16.00 mm:	annealed HB < 230

- Hardening capability: ≈ 45 HRc

Cutting conditions

Machinability:	satisfactory forms long chips
Cutting speed:	V_c ≈ 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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Forming

Warm: forging: 970 - 1100°C, slow cooling
Slow heating up to 830°C, then faster up to the forging temperature
Not recommended below 970°C
Cold: Relatively difficult
- Feasible after anneal: 750 - 825 °C, slow cooling

Welding

Not recommended

Annealing

Soft anneal: 730 - 880°C, holding time 2 – 4 h, slow furnace cooling
- Softening anneal: 650 - 750°C, air cooling

Intermediary anneal during cold deformation: 630 – 680°C
Minimal cold reduction: ≥ 10 - 15%, to avoid a too strong grain growth

Quenching

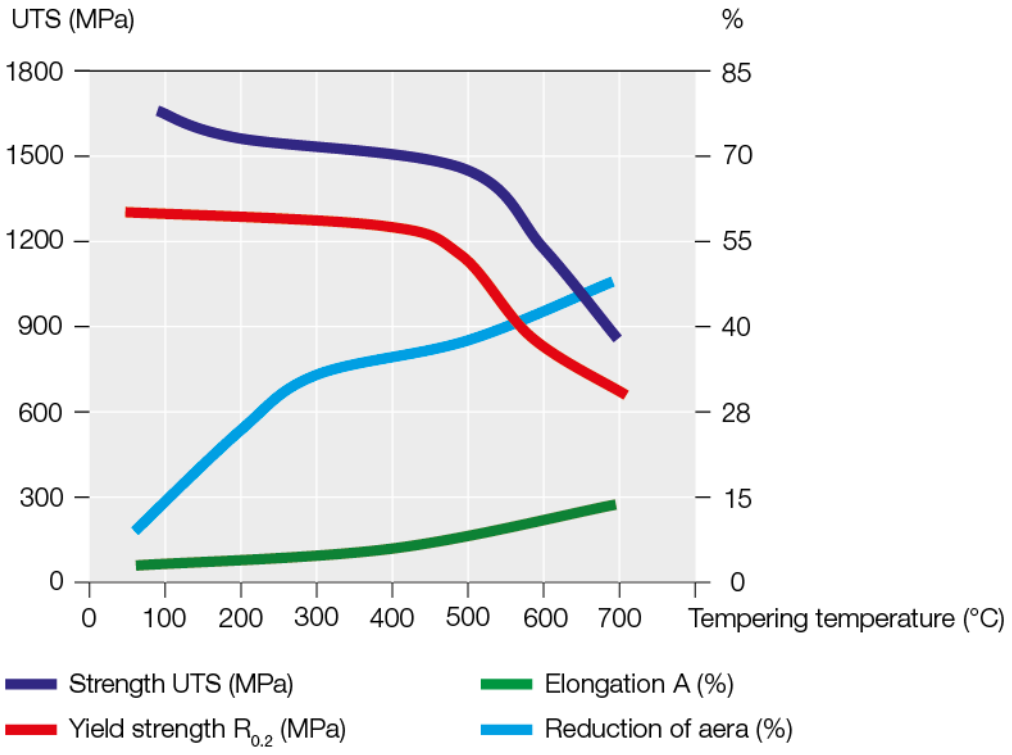
Primary quenching, oil, air or gas quench: 980 – 1030°C
Option: Secondary quenching by subzero treatment:
-20 à -80°C/12 - 48h, preferably -80°C/12 – 24h
or cryo-quenching:
-196°C/6 – 12h: progressive step-by-step cooling to avoid any possible cracking.
- The secondary sub-zero quenching should be made as soon as possible after the primary one.

More info.

Tempering

Tempering: according to needs, see Tempering diagram
- Not recommended in the temperature range: 400 – 580°C
  In this temperature range the precipitation of carbides at the grain boundaries may lead to brittleness and inter-granular corrosion.

Tempering diagram



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Microstructures

Delivery conditions: “annealed“ and “annealed + cold drawing“: ferrite + carbides
- Machining microstructure: ferrite + carbides

Heat treated QT condition: martensite + carbides
- Hard machining microstructure: (tempered) martensite + carbides

Microstructure at the optimal hardness for polishing: stress relieved martensite

Polishing

Amenable for mirror polishing
- Optimal in the heat treated condition, tempered < 200°C

Laser marking

- The Heat Affected Zone (HAZ) can lead to a local reduction of the corrosion resistance. More info.

Pickling and passivation

It is strongly recommended to use pickling and passivation procedures and solutions well adapted to the treatment of martensitic stainless steels.
- To avoid a “flash back“ reaction, it is strongly recommended to always pickle the surfaces before the passivation procedure. More info.

Corrosion resistance

Optimum: Clean, quenched, tempered, fine polished, and passivized surfaces.
- Conditions to avoid: “annealed“ and “annealed+ cold deformed“. These conditions should be avoided due to the increased inter-granular corrosion risk. These two conditions are definitively not recommended for parts in permanent use.
- The formation of oxides and scaling can strongly decrease the corrosion resistance. They must be eliminated either mechanically, or by pickling.

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.

Physical properties

Properties	Unit	Temperature (°C)				
		20	200	300	400	500
Density	g cm^{-3}	7.70				
Young modulus E	GPa	215			190	
Electrical resistance	Ω mm^2 m^{-1}	0.70				
Thermal expansion	m m^{-1} K^{-1}	20–100°C	20–200°C	20–300°C	20–400°C	20–500°C
	10^{-6}	10.5	11.0	11.5	12.0	12.0
Thermal conductivity	W m^{-1} K^{-1}	30				28.7
Specific heat	J kg^{-1} K^{-1}	460				
Melting range	1500 – 1430 °C					
Magnetism	Ferromagnetic, can be magnetized. More info.					