CHRONIFER® Labor M-Plus

Hardenable martensitic free machining stainless steel

Attributes and Particularities

The CHRONIFER® Labor M-Plus free machining stainless steel has an increased S content to enhance its machinability, especially on Swiss automatic machine tools. It has the second best machinability after the CHRONIFER Labor M-13 steel. The Mo and Ni additions provide a hardness increase, as well as a better corrosion resistance. This steel has a good wear resistance. However, its corrosion resistance can only be satisfactory if the parts are hardened, polished and passivated.

Uses and Applications

This steel is adapted to numerous applications of various types. More particularly for precision parts which must have both a good wear resistance and a satisfactory corrosion resistance.

Applicable standards

Material Number	~1.4197
DIN	≈ X20CrNiMoS13-1
AISI/SAE/ASTM	AISI 420F Mod, ASTM F899
AFNOR	
ISO	
Euro standards EN	
Others	

Chemical composition ($\%_{wt}$)

C	Si	Mn	P	S	Cr	Mo	Ni	Fe
0.20	max.	max.	max.	0.15	12.5	1.10	0.75	balance
0.26	1.00	2.00	0.04	0.27	14.0	1.50	1.50	

Dimensions and tolerances

Ø < 2.00 mm ISO h7 (h8) for bars
Ø ≥ 2.00 mm ISO h6 for bars
Ø ≥ 0.80 mm ISO fg7 for coils (for ESCO machines)
Out of roundness: max ½ of tolerance
- Other executions on request

Executions and Delivery conditions

Standard: in bars 3 m (+50/0 mm) and in coils for ESCO
- Bars Ø ≥ 2.00 mm: cold drawn, ground polished, rugosity max Ra 0.4 µm (N5)
  End of bars: Pointed, chamfered,
  eddy-current checked according to EN10277-1, Tab. 1
- Bars < 2.00 mm surface condition: cold drawn execution
- Coils for Escomatic machine: (Ø max size: 6.00 mm)
- SWISSLINE for bars Ø ≥ 6.00 mm
- Other executions on request

Availability

Standard dimensions on stock, see: Sale program

Mechanical properties

Standard delivery condition:

Strength UTS:	≈ 780 MPa, according to diameter
Ø 2.00 - <4.50 mm	775 – 925 MPa
Ø > 4.50 mm	775 – 905 MPa
• Hardness after hardening:	≈ 48 - 52 HRc

Cutting conditions

Machinability:	good, forms long chips
• Cutting speed:	V_c ≈ 40 - 55 m/min
• Lubricant cooling fluid i.e.:	INOX or ORTHO NFX

The optimal cutting conditions depend on the machine tool, the cutting tools, the chip dimensions (cutting depth and feed), the cutting speed, the lubricant-cooling fluid, as well as the tolerances and surface roughness to be produced.

L. KLEIN SA • Längfeldweg 110 • P.O. Box 8358 • CH-2500 Biel/Bienne 8
Telephone 0041 (0) 32 341 73 73 • Telefax 0041 (0) 32 341 97 20 • www.kleinmetals.ch • info@kleinmetals.ch

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Forming

Warm: Forgeing: 1150 – 980°C, not recommended below 980°C.
- Sensitive to cracking because of the numerous manganese sulfide (MnS) inclusions

Cold: limited, not recommended

Welding

Difficult, not recommended.
- Difficult because of the numerous manganese sulfide (MnS) inclusions. Mehr Info

Annealing

Soft annealing: 780 – 830°C, slow cooling 30°C/h bis 600°C, then in air
Sub-critical anealing: 650 – 760°C, air cooling
- Intermediate annealing during cold working: preferably 650 - 680°C, air cooling

Quenching

Primary quench, oil, or rapid cooling in air or gas: 1000-1050°C
Optional: secondary quench by sub-zero cooling
Recommendation: To obtain the best efficiency, this secondary quench must be made without delay after the primary one.
- -20 down to -80°C/12 – 48h, preferably -80°C/12 – 24

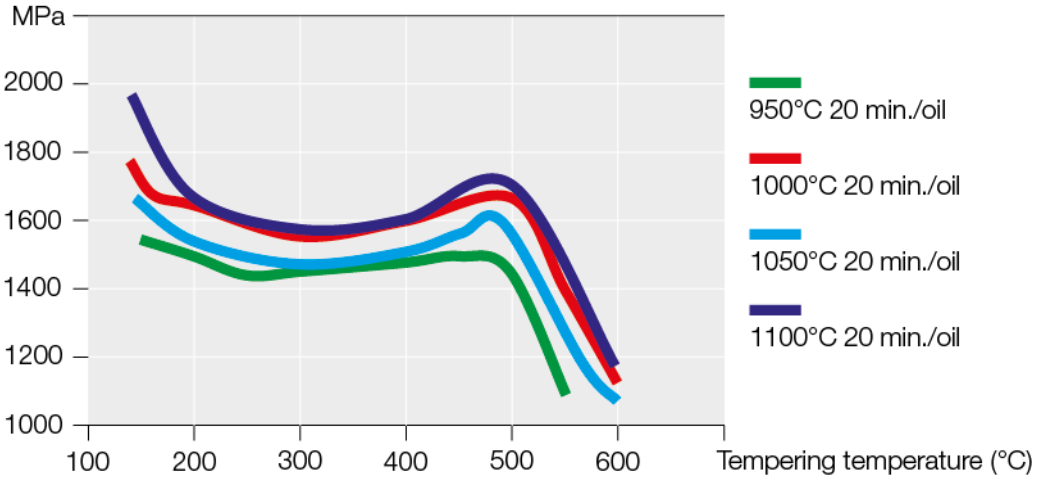
Or cryo-treatment (deep cryo-cooling):
- -196°C/6 – 12h, progressive or step by step cooling to avoid a possible cracking.

Mehr Info

Tempering

According to needs, see Tempering diagram
- The temperature range 400 – 580°C should be avoided because of the increased risk of brittleness and reduction of the corrosion resistance.

Tempering diagram



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Microstructures

Delivery conditions: annealed and «annealed + cold drawn»: Ferrite + carbides
- Machining: Ferrite + carbides

Quenched and tempered: Martensite + carbides
- Hard machining: Martensite + carbides
- Microstructure for an optimal polish: Stress releived martensite + carbides
- Microstructure for polishing: Martensite + carbides

Polishing

Optimal: Quenched and tempered < 180°C. Is not adapted to mirror polish.
- The presence of numerous manganese sufide (MnS) hamper the quality of the polish and is economical yield.

Laser marking

- The presence of numerous manganese sufide (MnS) can reduce the feasibility of a quality laser marking.
- The laser marking heat in the Heat Affected Zone (HAZ) may modify the local microstructure and affect negatively its corrosion resistance. More info

Passivation

The adequacy of the selected passivation process should be checked with respect to the numerous MnS inclusions of this free machining grade.
- The numerous manganese sulfide (MnS) inclusions may significantly impair the quality of the passivation process. A pickling prior to passivation is highly recomended. It should not be reasonably skipped over. More info

Corrosion resistance

Optimum: Clean, quenched, tempered, fine polished, and passivated surfaces.
- The numerous inclusions of manganese sulfide (MnS) increase the sensitivity to pitting corrosion.
- Conditions to avoid: annealed and “annealed+ cold deformed“. These conditions should be avoided because of the increased corrosion risk. They are definitively not recommended for the permanent use of parts.
- The possible formation of oxides and scaling can strongly decrease the corrosion resistance. These oxidations should always be eliminated either mechanically by an abrasion process, or better, by pickling.

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

Physical properties

Properties	Units	Temperature (°C)				
		20	200	300	400	500
Density	g cm^{-3}	7.70				
Young Modulus E	GPa	215	205		190	
Electrical resistance	Ω mm^2 m^{-1}	0.60				
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	12.0		
Thermal conductivity	W m^{-1} K^{-1}	24.9				
Specific heat	J kg^{-1} K^{-1}	460				
Melting range	Average melting range: 1500 – 1420 °C					
Magnetisms	Ferromagnetic, can be magnetized. More info					