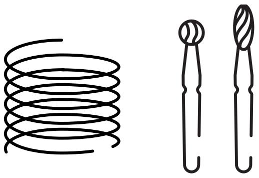
Zapp 2205 Data Sheet
Medical Wire

Zapp is certified according to ISO 9001



Zapp 2205

Zapp 2205 is a duplex stainless steel (austenitic-ferritic).

The Grade is Characterized by:

- Very good fatigue resistance
- High resistance to stress corrosion cracking in chloride-bearing environments
- High resistance to general corrosion, pitting, and crevice corrosion
- High resistance to erosion corrosion and corrosion fatigue
- Physical properties that offer design advantages

Standards

- UNS: S32205/S31803
- EN Number: 1.4462
- EN Name: X2CrNiMoN22-5-3
- W.No.: 1.4462

Applications

Zapp 2205 can be used for dental instruments.

Chemical Composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo	N
≤ 0.030	0.5	0.9	≤ 0.030	≤ 0.015	22.0	5.0	3.2	0.18

Forms of Supply

The wire can be supplied in the following surface finishes:

- Coated
- Bright drawn
- Nicoat A (nickel coating + dry drawn)
- Nicoat P (nickel coating + bright drawn)
- Mechanically polished

Depending upon dimension, surface finish and customer requirements the material can be delivered on spools, in coils or as straightened lengths.

Mechanical Properties

At 20 °C (68 °F)

Examples of tensile strength (R_m) and proof strength ($Rp_{0.2}$[1)]) in the 'as delivered' condition. Other mechanical properties can offered upon request.

Wire diameter		Nominal, R_m		Nominal, $R_{p0.2}$	
mm	in.	± 100 MPa	± 15 ksi	MPa	ksi
0.15 – 0.20	0.0059 - 0.0079	2,250	326	1,915	278
> 0.20 – 0.30	> 0.0079 - 0.012	2,200	319	1,870	271
> 0.30 – 0.50	> 0.012 - 0.020	2,100	305	1,785	259
> 0.50 – 0.80	> 0.020 - 0.031	2,000	290	1,700	247
> 0.80 – 1.25	> 0.031 - 0.049	1,900	276	1,615	234
> 1.25 – 2.00	> 0.049 - 0.079	1,800	261	1,530	222
> 2.00 – 3.50	> 0.079 - 0.138	1,650	239	1,405	204
> 3.50 – 5.00	> 0.138 - 0.197	1,550	225	1,320	191
> 5.00 – 8.00	> 0.197 - 0.315	1,450	210	1,235	179
Annealed wire		800	116	450	65
Intermediate strength levels		On request			

[1)] $R_{p0.2}$ corresponds to 0.2% offset yield strength

Tensile strength can be increased by 200 MPa (29 ksi) up to 450 MPa (65 ksi) by tempering depending on tensile and tempering conditions. Please ask us for more information of heat treatment. The tensile strength variation between spools/coils within the same production lot is ±50 MPa (7 ksi) maximum. Yield strength in the tempered condition is approx. 90 % of the tempered tensile strength. Tensile strength values are guaranteed and are measured directly after production. During storage, both the tensile strength and yield strength will increase somewhat due to ageing. Depending on the storage conditions, the tensile strength can increase by 0 – 80 MPa (0 – 12 ksi).

The tensile strength and yield strength will decrease by 3 – 4% per 100 °C (210 °F) increase in service temperature.

Straightened Lengths

Straightening will reduce the tensile strength by approx. 7 %.

Fatigue Strength

The diagrams below are based on tempered and pre-stressed cylindrical helical springs with a wire surface free from tooling damage.

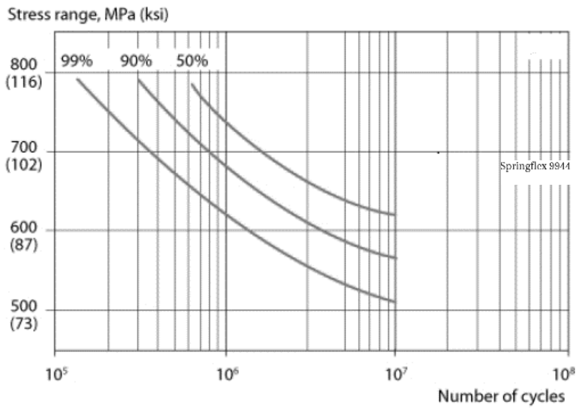


Figure 1. Wöhler diagram, mean stress 450 MPa (65 ksi). The curves re valid for springs coiled from wire 1.00 mm (0.039 in.) in diameter and represents 50 %, 90 % and 99 % certainty against failure. Stress range = double the stress amplitude.

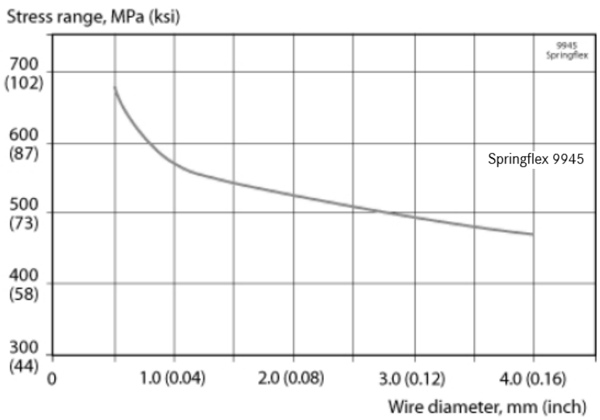


Figure 2. Stress range for different wire diameters, mean stress 450 MPa (65 ksi). Stress range at 10^7 load cycles as a function of the wire diameter and 90 % certainty against failure.

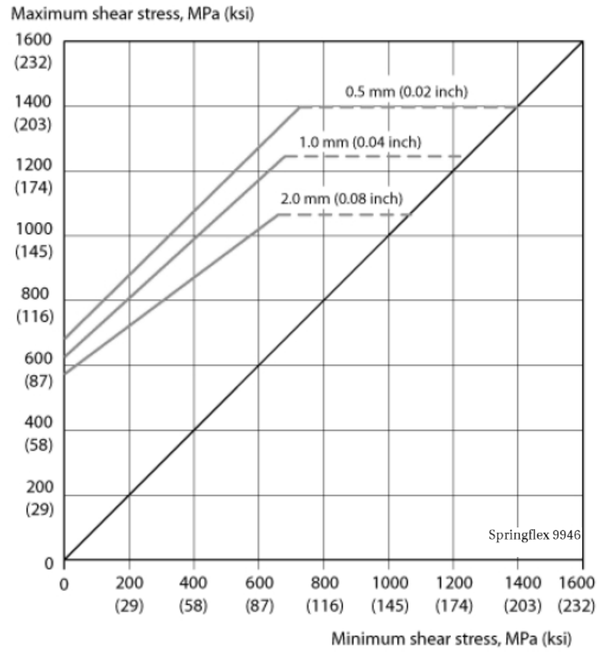


Figure 3. Modified Goodman diagram for different wire diameters. The curves are valid for 10^7 load cycles and represent 90 % certainty against failure. They are limited by the setting limit.

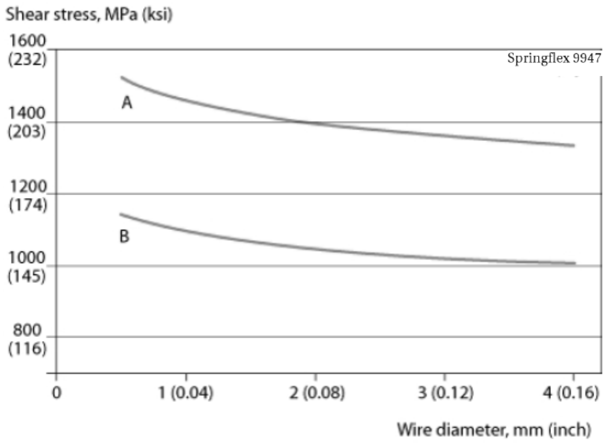


Figure 4. Setting limit and maximum permissible shear stress. Setting limit curve A, and maximum permissible shear stress, curve B, as a function of the wire diameter. The setting limit is defined as the shear stress at which the relaxation is 2 % after a load time of 24 hours. Curve B lies 25 % below curve A.

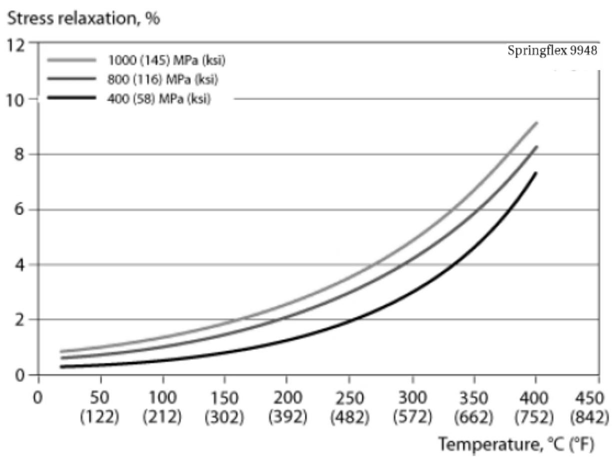


Figure 5. Relaxation 24 hours. Relaxation (load loss) at various shear stresses as a function of service temperature. This diagram refers to a wire diameter of 1.0 mm (0.039 in.).

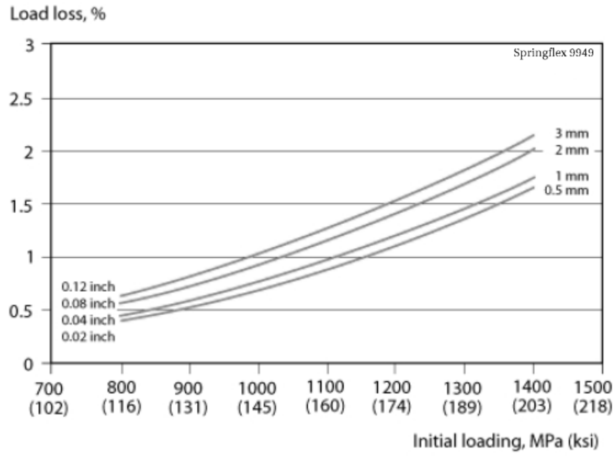


Fig 6. Relaxation, 24 hours. Relaxation (load loss) at various shear stresses as a function of wire diameter.

At elevated temperatures, the fatigue strength decreases at

_ 100 °C (210 °F): by about 5 %
_ 200° C (390 °F): by about 10 %

Physical Properties

Density: 7.8 g/cm^3 , 0.28 lb/in^3

Specific heat capacity

500 J/kg °C	in the temperature range 50 - 100 °C
0.12 Btu/lb °F	in the temperature range 120 - 212 °F

Thermal Conductivity

Temperature °C	W/m °C	Temperature °F	Btu/ft h °F
20	14	68	9
100	16	212	9
200	17	390	10
300	19	570	11

Resistivity

Temperature °C	µΩm	Temperature °F	µΩin.
20 - 100	0.84	120 - 212	33.0

Thermal Expansion

Mean values in temperature ranges (x10^{-6})

Cold worked

Metric units

Temperature °C per °C	30 - 100	30 – 200	30 - 300	30 – 400
	12.5	11.5	11.5	12.0

Imperial units

Temperature °F per °F	86 – 200	86 – 400	86 – 600	86 – 800
	7.0	6.5	6.5	6.5

Aged

Metric units				
Temperature, °C per °C	30 – 100	30 - 200	30 - 300	30 – 400
	13.0	13.5	13.5	14.0

Imperial units				
Temperature, °F per °F	86 - 200	86 - 400	86 - 600	86 - 800
	7.0	7.5	7.5	8.0

Magnetic permeability, μ_{max}				
Annealed	-	-	-	60.0
Cold drawn	-	-	-	120.0

Shear Modulus, MPa (ksi)

as delivered: approx. 77,000 (11,165)
tempered: approx. 79,000 (11,455)

Modulus of Elasticity, MPa (ksi)

as delivered: approx. 200,000 (29,000)
tempered: approx. 205,000 (29,725)

Crevice Corrosion

Crevice corrosion is in principle the same as pitting corrosion, but occurs in crevices and cracks, e.g. between flange joints, under deposits on the metal surface or in welds with incomplete penetration.

Crevice corrosion often occurs at lower temperatures and at lower chloride contents than those necessary for pitting to occur. Resistance is influenced by the content of Cr, Mo and N, in the same way as pitting resistance.

Stress Corrosion Cracking

The standard austenitic steels of the ASTM 302/304 and ASTM 316L types are prone to stress corrosion cracking (SCC) in chloride-bearing solutions at temperatures above 60 °C (140 °F).

Duplex stainless steels are far less prone to this type of corrosion. Laboratory tests have shown the good resistance to stress corrosion cracking of Zapp 2205.

Pitting

The pitting resistance of a steel is determined primarily by its chromium and molybdenum contents, but also by its nitrogen content, as well as its slag composition and slag content. A parameter for comparing the resistance of different steels to pitting is the PRE number (Pitting Resistance Equivalent).

The PRE is defined as, in weight-%:
PRE = % Cr + 3.3 x % Mo + 16 x % N
The PRE numbers for Zapp 2205 and two standard materials are given in the following table.

Grade	% C	% Mo	% N	PRE
Zapp 2205	22.0	3.2	0.18	35.0
ASTM 316L	17.0	2.2	-	24.0
ASTM 302/304	18.0	-	-	18.0

The ranking given by the PRE number has been confirmed in laboratory tests. This ranking can generally be used to predict the performance of an alloy in chloride containing environments.

Bending

The minimum bending radius should not be less than half the wire diameter. The wire surface should be free from any tooling damage because slight imperfections in the surface can lead to fracture, even at large bending radii.

Heat Treatment

Spring tempering will increase the tensile strength with up to to 450 MPa (65 ksi) depending on initial tensile strength. We recommend 450 °C (840 °F)/1 – 3 h for batch tempering.

To obtain the best results, when tempering in a continuous conveyor furnace, where holding times at full temperature are very short, the temperature should be increased preferably to about 500 °C (930 °F).

The holding time should be 3 – 10 minutes. Shorter times may result in uneven tempering.

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