Material Types

Selecting Material Types

Selecting the appropriate material for your ring or spring is essential for avoiding additional cost and failure in operation. TFC supply many raw materials for various operating conditions including extreme temperatures and corrosive environments.

Carbon Steel

TFC offers two standard carbon steel materials for retaining rings and wave springs. Carbon steel is cost effective and durable, but has low corrosion resistance. It is highly magnetic and can be a variety of colours such as blue, grey, or black. Carbon steel products are oil-dipped for protection during shipment and shelf storage.

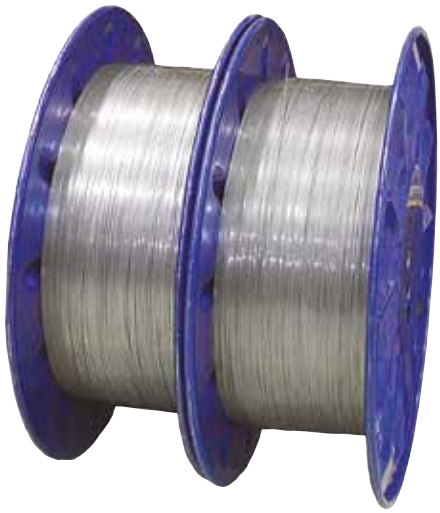
SAE 1070-1090

SAE 1070-1090 high carbon spring steels are oil tempered and are the most commonly used carbon steels. Tensile and yield strength are maximised because of the oil tempered martensitic structure.

SAE 1060-1075

SAE 1060-1075 high carbon cold drawn spring steels receive their strength from cold rolling.

In either temper, carbon steel is suited for use in a protected environment, as it corrodes if not oiled and sealed from the elements. Additional corrosion protection can be achieved with special finishes.



Stainless Steel

TFC offers three stainless steel materials for retaining rings and wave springs. 302 and 316 are standard materials for retaining rings and 17-7 PH is the standard material for wave springs. Stainless steel, although more costly than carbon steel, is more corrosion resistant and able to withstand higher temperature limits. It is slightly magnetic and can be a variety of colours such as blue, brown, and silver. Stainless steel products usually undergo ultrasonic cleaning and vapor degrease finishing processes.

302

302 is specified because of its combination of corrosion resistance and physical properties. 302 stainless steel gains spring temper condition by cold working. Although it is categorised as a nonmagnetic stainless, 302 becomes slightly magnetic because of the cold working. It cannot be hardened by heat treatment.

316

316 is nearly identical in physical properties and heat resistance to 302. It provides more corrosion resistance because of the addition of molybdenum, particularly against pitting. As with 302, the magnetism of 316 increases as the wire is cold worked. It cannot be hardened by heat treatment.

17-7 PH Condition CH900

17-7 PH Condition CH900 is similar in corrosion resistance to 302 and offers both high tensile and yield strength. In fatigue and high stress applications, 17-7 outperforms even the finest grade of carbon steel. Spring properties are achieved by precipitation hardening Condition C to Condition CH900. As a result, the material may be subjected to a temperature of 343˚ C without a loss of spring properties. Its magnetism is similar to carbon steel. After precipitation hardening, 17-7 has a blue, brown, or silver colour; atmosphere-controlled heat treatment provides a brighter colour.

Material Types

Super Alloy

TFC offers super alloys when carbon and stainless steels do not meet an application's unique requirements. Super alloys maintain material properties in extreme operating conditions. These materials exhibit no magnetism and can be blue, brown, or silver in colour.

Materials may be heat treated in open-air or in an atmosphere-controlled furnace. Open-air heat treatment may produce scale, which often results in a dark residue. An atmosphere-controlled environment eliminates scale and produces a part with a brighter finish.

Inconel®[1] X-750
Inconel X-750 is a nickel-chromium alloy and precipitation heat treated to a spring temper condition. In this state, it has temperature resistance up to 371° C. Additional temper methods are available to achieve slightly different physical properties. TFC can also offer NACE (The National Association of Corrosion Engineers) approved materials to meet your requirements.

A286 Alloy
A286 is a nickel-iron-based alloy that exhibits similar properties to Inconel X-750, but with additional heat resistance of up to 538° C. Its spring temper condition is obtained by precipitation hardening.

Elgiloy®[2]
Elgiloy is a cobalt-based alloy known for its high strength and excellent corrosion resistance. It can be used in environments up to 427° C. Elgiloy shows improved resistance to sulfide stress cracking over other NACE approved materials.

MP35N®[3]
MP35N is a nickel-cobalt-based alloy known for its high strength and corrosion resistance. It can be used in environments up to 316° C. It is often specified for oil and gas applications.

Hastelloy®[4] C-276
Commonly used in chemical processing industries, Hastelloy C-276 is a nickel-based alloy with a proven performance in corrosive applications. Similar to other nickel-based alloys, it is ductile, easy to form, and has excellent resistance to stress corrosion cracking in chloride solutions. It can be used in environments up to 399° C.

Monel®[1] K-500
Monel K-500 is a nickel-copper-based alloy known for its excellent corrosion resistance, strength, and hardness properties. It can be used in environments up to 288° C.

[1]INCONEL X-750 and MONEL are registered trademarks of Special Metals Corporation.
[2]ELGILOY is a registered trademark of Combined Metals of Chicago.
[3]MP35N is a registered trademark of SPS Technologies Inc.
[4]HASTELLOY is a registered trademark of Haynes International.

Material Types

Copper

When magnetism or conductivity are important to your application, TFC offers a range of copper materials. There are two major types of copper alloys as custom materials availble.

Beryllium Copper Alloy #25

Beryllium copper is nonmagnetic and one of the most electrically conductive materials TFC offers. Normally specified in a hard temper, it has a combination of low modulus of elasticity and high ultimate tensile strength. The alloy gains its physical properties by precipitation hardening. In contrast to other copper alloys, beryllium copper has the highest strength and is suitable to use at temperatures up to 204˚ C.

Phosphor Bronze, Grade A

Phosphor bronze is a nonmagnetic alloy with fair electrical conductivity. It is purchased in a spring temper condition to maximise spring characteristics and can be hardened only by cold working. Phosphor bronze exhibits fair spring properties and is rated a step below beryllium copper in performance.

Additional Materials

In addition to the materials listed above, TFC offers 410 Stainless Steel, Waspaloy and others. If you have questions on these materials or do not see your desired material listed, please contact TFC Engineers for further details.

Materials Table

Material	Material Thickness (mm)	Minimum Tensile Strength (N/mm²)	Shear Strength (N/mm²)	Maximum Recommended Operating Temp (°C)	Modulus of Elasticity (N/mm²)	Chemical	AFNOR	Number-DIN
Carbon Steel								
Oil Tempered SAE 1070 – 1090	0,152 - 0,356	1855	1055	121	$20,7 \times 10^4$	Carbon Steel XC67 to XC75	N/A	1,1231-1,1248[1]
	0,357 - 0,533	1758	1000					
	0,534 - 1,092	1524	869					
	1,093 & larger	1455	827					
Hard Drawn SAE 1060 - 1075	0,152 - 0,762	1586	896					
	0,763 - 2,794	1248	710					
	2,795 - 5,588	1076	614					
Stainless Steel								
AISI 302 AMS-5866	0,051 - 0,559	1448	820	204	$19,3 \times 10^4$	X10 CrNi 18-8	N/A	1,4310
	0,560 - 1,194	1379	786					
	1,195 - 1,575	1276	724					
	1,576 - 1,880	1207	689					
	1,881 - 2,261	1138	648					
	2,262 & larger	1069	607					
AISI 316 ASTM A313[1]	0,051 - 0,584	1344	765			X 5 CrNiMo 17-12-2	Z 7 CND 17-12-2	1,4401
	0,585 - 1,219	1310	745					
	1,220 - 1,549	1207	683					
	1,550 & larger	1172	669					
17-7 PH/CH900 Condition CH900 AMS-5529		1655[2]	945[2]	343	$20,3 \times 10^4$	X 7 CrNiAl 17-7	Z 9 CNA 17-07	1,4568
Exotic Alloys								
A-286 AMS-5810		1276[2]	724[2]	538	$21,4 \times 10^4$	X 6 NiCrTi-MoVB 25-15-2	Z6NCT-DV25-15	1,4980
INCONEL® Alloy X-750 Spring Temper AMS-5699[3]		1517[2]	862[2]	371		NiCr 15 Fe 7 TiAl	NC 15 Fe 7 TA	2,4669
INCONEL® Alloy X-750 No. 1 TEMPER "Rc 35 Maximum" AMS-5699[1,3]		938 REF	531					
INCONEL® Alloy X-750 No. 1 TEMPER AMS-5698		1069[2]	607[2]	538				
INCONEL® Alloy 718 AMS-5596[1]		1241[2]	703[2]	704	$20,4 \times 10^4$	NiCr 19 NbMo	NC 19 FeNb	2,4668
ELGILOY® AMS-5876[1,3]	≤ 0,102	2068[2]	1179[2]	427	$20,7 \times 10^4$	CoCr20 Ni16 Mo7	N/A	N/A
	0,103 - 0,483	1999[2]	1138[2]					
	0,484 - 0,635	1931[2]	1096[2]					
	0,636 - 2,540	1862[2]	1062[2]					
BERYLLIUM COPPER TEMPER TH02 ASTM B197[1]		1276[2]	883[2]	204	$12,8 \times 10^4$	CuBe2	N/A	2,1247
MP35N® AMS 5758[1]		1655	1034	316	$23,5 \times 10^4$	N/A	N/A	2,4999
Hastelloy® C-276 ASTM B 74[1]	< 0,406	1586	903	399	$20,5 \times 10^4$	NiMo 16Cr15W	N/A	2,4819
	0,406 - 0,813	1448	820					
	0,813 - 1,372	1379	786					
	1,372 & larger	1310	745					
Monel® K-500 QQ-N-286[1]		1172	669	288	$17,9 \times 10^4$	NiCu30Al	N/A	2,4375

Note: Additional materials available include Phosphor Bronze, 410 Stainless Steel, MONEL® 400, Waspaloy®, Duplex Stainless and others. Please consult TFC for further details.

[1] Referenced for chemical composition only.
[2] Values obtained after precipitation hardening.
[3] Conforms to NACE Standard MR0175.
[4] Exceeding these temperatures will cause relaxation. Consult TFC Engineering for High Temperature Applications.

Material Finishes

Finishes, Plating & Coating

After selecting the appropriate material for your application, adding a finish, plating or coating may be necessary to meet your application requirements. These additional processes can improve the function, look, and performance of the part.

Black Oxide

MIL-DTL-13924, Class 1

This finish provides a flat black appearance that is generally used to alter cosmetic appearance instead of an improvement in corrosion resistance.

Oil Dip

This is the standard finish for all products produced from carbon steel. The oil provides resistance to corrosion in transport and normal storage. The oil dip finish should not be considered a permanent finish.

Passivation

AMS 2700, Method 1, Type 2, Class 3

Passivation is an optional cleaning operation for stainless steel. It provides a bright finish and increased corrosion resistance. Passivation dissolves iron particles and other substances that have become embedded in the surface of the stainless steel during production. If not dissolved, these foreign particles could promote corrosion, discolouration, or pitting.

Vapor Degrease/Ultrasonic Clean

This is the standard cleaning and finish for all products manufactured in stainless steel. The process removes oil and other organic compounds from the material surface by use of a degreasing solvent, which is forced between the turns of the part with ultrasonic waves.

Vibratory Deburr/Hand Deburr

Although all circumferential surfaces and edges of products are smooth, sharp corners can be present on the gap ends due to the cut-off operation. To break the sharp corners and achieve a smooth surface finish, parts may be either vibratory or hand deburred to meet your specifications.

Zinc Phosphate

MIL-DTL-16232, Type Z, Class 2

Sometimes referred to as “Parkerising”, zinc phosphate appears grey-black in colour. The corrosion resistance of phosphate is superior to black oxide but inferior to stainless steel. Zinc phosphate cannot be applied to stainless steel.

Zinc Plating

Zinc Plate, ASTM B633, Type V, Fe/Zn 5, SC1 (Colourless)

Zinc Plate, ASTM B633, Type VI, Fe/Zn 5, SC1 (Coloured Chromate)

Zinc plating is used on carbon steel to increase the corrosion resistance of the product. It is sometimes used as a more cost effective alternative to other plating options or stainless steel. Standard zinc platings, Type V and Type VI, are RoHS compliant. The thickness level of the plating is controlled by the service condition number (SC Number), which should be designated by the customer. Zinc plating does not guarantee coverage between the turns of multiple turn rings and springs. (The process does subject the part to the possibility of hydrogen embrittlement. We offer stainless steel as a preferable alternative.)