# A Layman's General Guide To Stainless Wire

**What are the uses for stainless steel?**
Stainless steels are used primarily for their resistance to corrosion and heat. They can be used for both high and low temperature applications and possess good resistance to abrasion and wear.

**What are the most common grades for stainless steel spring manufacturing?**
The most common spring wire grades are T-302, T-304, T-316. These grades are considered to be austenitic stainless grades and will not gain strength after heat treatment. Their high strength is created by cold drawing.

**Are there other common stainless grades that gain strength after heat treatment?**
17-7PH stainless is also a very common spring grade. The PH stands for precipitation-hardening. This material will gain strength after heat treating. Suggested heat treat is 1 hour at 900 degrees. After heat treat this material will gain tensile strength. This allows the spring maker to coil the material in the as drawn condition (Condition C) and then heat treat the springs to gain strength (Condition CH). Although not considered to be a 18-8 stainless due to the lower chrome and nickel, 17-7PH has the addition of aluminum which precipitates out of the steel during the heat treat process giving the steel additional strength with a potential gain in tensile strength of 30,000 psi plus.

The chart below reviews these stainless grades of steel most often used in spring manufacturing.

| Type | %Cr | %Ni | Other | Maximum Strength PSI | Applications and Comments |
|---|---|---|---|---|---|
| 302 | 17-19 | 8-10 | | 350 KSI | Most common spring grade. High strength, Good corrosion properties. |
| 304 | 18-20 | 8-12 | | 320 KSI | Typically softer then T-302. Easier to form. Used in the annealed conditions for fasteners and cold heading applications. Some 302 will meet chemistry of 304 but not vice versa. |
| 316 | 16-18 | 10-14 | Mo | 240 KSI | Superior corrosion properties when compared to 302 and 304 due to the addition of Molly. Lesser strength then 302 and 304. |
| 17-7 | 16-18 | 6-8 | Al | 380 Ksi | Highest strength in CH condition. Gains strength after heat treat 1 hour at 900 degrees. Same corrosion properties as 302. |
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**Are there any other grades of stainless that might be considered for spring making?**
The 300 series of stainless grades which also include grades such as 304, 321 and 347 are considered Austenitic (Cr-Ni) grades of stainless. They typically cannot be hardened by heat treat. They are hardened by cold working or drawing.

Some of the 400 series of stainless are considered to be Martensitic or Ferritic which unlike the 300 series of stainless can be hardened by heat treatment. This series typically is used in applications such as fasteners, lock wire and normally used in the annealed condition which allows eaiser formability. The 400 series is typically not used in the Spring Industry unless formed into some type of wire form. These are the least expensive grades of stainless and exhibit diminished strength and corrosion properties when compared to the 300 series.

**What coatings are available to make it easier for springmakers to process material ?**
**Gibbscote** is a non-metallic coating also called referred to as a soap coating. Typically coatings are put on the wire for ease of drawing the wire but also to provide lubricant for the spring coilers. This is a two step process. A pre-coat is put on the wire in the annealed condition. Drawing soaps then adhere to the pre-coat during the drawing stage. The coating is then made up of the pre-coat and drawing soaps. Every stainless mill uses different pre-coats and drawing soaps so the actual non-metallic or soap coating will vary between mills. This is the least expensive coating available for stainless wire.

**Nickel Coat** is a metallic premium coating for stainless wire. It provides excellent lubricant for the spring coiler and is a very consistent coating. Nickel is applied using in electrolytic process while the wire is in an annealed condition. The product is subsequently drawn providing excellent adherence. Nickel is typically more expensive then a soap coating. Nickel can drawn in soaps or oil. Soap drawn nickel provides more lubrication as the soap will adhere to the nickel during the drawing process. Drawing nickel in oil provides less lubrication but produces cleaner material without the soap residue. Not all wire mills have the capability to provide this type of coating.

**Are there various strength properties for stainless steel and how are they achieved?**
Mills draw stainless wire to smaller diameters using material that is in the annealed state. Annealing is a heat treating process to acheieve high ductility to prepare the wire for drawing. After annealing the wire is considered soft (tensile range of 80/120,000 psi). This wire is subsequently drawn to a specific gauge. During this drawing process the material work hardens and gains strength. For example, a springmaker may order .040 diameter in the spring temper condition. (Spring temper material is the hardest the material can achieve with out becoming brittle). The mill may begin the process of drawing the stainless to the .040 requested size by starting with .250 diameter material. At .250 diameter the material would be soft ( in the annealed state or condition). This material would then be drawn through a series of dies to reduce the diameter and in so doing, the material would gain strength as well. However, the steel can only be drawn (reduced in diameter) so much before becoming too hard or brittle. In this example let’s assume the mill draws the material from .250 to .100 diameter. At that point, the material becomes becomes too hard to draw to a narrower diameter. Nevertheless, the mill still

needs to do further drawing to reduce the material to the .040 diameter that the spring maker ordered. The mill must therefore soften the wire by annealing so that we can complete the process of drawing to the finished size of .040. Once the annealing process is completed, the material is again soft, but still at .100 diameter. Now the mill can draw the wire again through a series of dies reducing it a little through each die (reduction in area) until it reaches it the ordered .040 diameter. At that point it will be within its required tensile strength of full hard or spring temper and the process will of been completed. Each finished diameter of material has an exact process that the mill uses to produce the desired diameter and tensile. This process may have to be adjusted slightly depending on the exact chemistry of the material involved. The goal is to meet the diameter tolerance in this example of .040 diameter +-.0008 and a tensile requirement of 275/304,00 psi. (ASTM A313).

**How do operating temperature conditions that material will be subjected to affect the selection of the proper grade?**
Operating temperatures for the 300 series of stainless are suggested to be up to 550 degrees. If higher operating temperatures are required we you may consider 17-7PH as it will operate in the range up to 650 degrees. If even higher requirements are required for a specific application you would want to select one of the Superalloys like Inconel 750x or Inconel 600.

**How does stainless steel achieve its corrosion resistance properties?**
Passivating is recommended for all stainless materials. The corrosion properties of stainless steels are attributable to a very thin layer of chromium oxide film that completely covers the surfaces of the parts and prevents corrosion from taking place. The primary purpose of a passivating treatment is to remove surface contamination, usually iron, so that this film layer is not interrupted. Passivating of stainless is done by immersing the parts in a nitric acid solution for a given amount of time ( normally 30 minutes).

**Stainless wire work hardens as it is being processed during the spring making operation. How does the spring maker adjust for the work hardening and stresses that take place during this operation?**
Stress relieving is suggested on stainless finished parts such as springs after the coiling process takes place. During the spring coiling process additional stresses will be introduced into the wire. Stress relieving is the process of heating material to a suitable temperature after forming. The product is held at a specific temperature long enough to reduce the residual stresses. It is then cooled slowly enough to minimize the development of new residual stresses. It is recommended that the 300 series stainless be stress relieved at 700 degrees for one hour. The suggested stress relief for 17-7PH is 900 degrees for one hour.

**What are some of the common specifications for stainless wire?**
The most common specification for stainless spring materials is ASTM A-313. This spec applies to T-302/304 and T-316. AMS-5688 is another popular specification for these grades. 17-7PH (Type 631) is also defined by ASTM A313 , and AMS-5678. Other specific customer specs are available upon request.

**What is bright wire and where is it typically used?**
Bright Wire refers to a finish not typically recommended for spring coiling due to the fact that it is not well lubricated. It is used primarily in applications where a bright shinny wire is needed for cosmetic reasons. Medical wire is an application where bright wire is used as a standard finish. Wire is drawn with oil in diamond dies to provide the bright and smooth surface finish.. Fine sizes .030 and below can be provided with this finish in the spring temper condition.

**What does it take to manufacture good stainless spring wire?**
The bottom line is consistency. One of the most important wire characteristics that the mills must control is cast and helix consistency. It is not so much the actual cast and/or helix that the mill is working to achieve (although mills do have their own internal guidelines). It is more of a function of holding the cast and helix consistent throughout the entire length of the coil. This provides a consistency of wire material going into the spring coiler which obviously is very important. If the cast or helix varies at the spring coiler, it is likely that the operator will need to make adjustments in order to adequately process or run the material through the coiling operation.

**Does coating consistency play a role in making good spring wire?**
Yes, a key factor in producing good stainless spring wire is coating consistency. The nickel coated product typically runs much better during the coiling process than does a soap coated product. This is due to the nickel metallic coating that provides excellent lubrication and allows for better control during the drawing process. It is a much smoother and consistent coating than soap. The obvious negative is the higher cost of the nickel coated wire when compared to that of the soap coated product. In the finer sizes of stainless wire you will find more nickel coated material being used while in the heavier sizes more soap coat is more common. This is because the finer sizes are more demanding at the coiler, so a more consistent product is needed to manufacture acceptable springs.

**What are “hard spots” and/or “soft spots”?**
Springmakers sometimes note that material will not run consisitently through their coiling operation due to hard and/or soft spots in the material. This issue can be attributed to coating variation. To better understand this, please consider the fact that the majority of springs are coiled on a point. This point turns the wire around itself into a spring. Coating inconsistencies generally reveal themselves at the coiling point. The coiling equipment will sense an absence or decreased amount of coating as a hard spot. Conversely, soft spots are generally attributable to an excess of coating. Gibbs works with our mill suppliers to assure that coating consistency is achieved in both soap drawn and nickel drawn product.

**What role does diameter tolerance consistency play in making good spring wire?** Another key consistency factor in manufacturing a good spring wire is diameter control. If the diameter varies the same cause and effect that occurs with inconsistent coating is once again evidenced at the coiling point. Moreover, this will cause dimension variation in the spring.