# A Layman's General Guide To Carbon Wire

**How Do Springmakers Utilize Carbon Steel In the Manufacturing Process?**
Carbon wire products, unlike those produced from those produced from stainless steel, have very little inherent corrosion protection. However, the high carbons offer higher strength and excellent fatigue characteristics when compared to the stainless steels. Carbon materials can be classified as High Carbon C-1044 and higher; Medium High Carbon C-1023 to C-1044; Medium Low Carbon C-1016 to C-1023 and Low Carbon C-1015 and lower.

**Is There Any Significance to The Letters and Numbers In the Grade Designations?**
Yes, for example, in the designation C-1008, the C and the 10 stand for carbon materials. The number after the 10 calls out the range of the carbon content in the steel. C-1008 is a low carbon grade with the carbon content of 8%.

**Why Does the Carbon Content Make a Difference?**
As the carbon content falls so does the strength of the material and, for that matter, the cost. The higher carbon materials work in the 250 degree max range. By comparison, the 300 series stainless spring wire grades operate in the 450 degree range. The majority if not all of what Gibbs stocks falls into the high carbon ranges. If a spring application requires the strength of a high carbon product, but needs to operate in a higher temperature environment, springmakers and engineers usually consider low alloy steel -i.e. either Chrome Silicon or Chrome Vanadium. These two grades of carbon steel will operate at temperature levels of 425 to 450 degrees.

**What are the various types, carbon content, specifications, characteristics, suggested stress relief temperatures and applications for carbon steel materials that are available to spring makers?**

| Type | % Carbon | ASTM Spec. | Maximum Strength PSI .032 diameter | Suggested Stress Relief | Applications and Comments |
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| Music Wire | .70 to .100 | A 228 | 360 KSI | 450 degrees 1 hour | Highest strength and most common carbon spring grade. Sometimes called piano wire. Mainly used for small springs due to the excellent fatigue characteristics.. |
| Hard Drawn MB | .45 to .85 | A 227 | 306 KSI | 450 degrees 1 hour | All purpose spring wire lesser strength then music and cheaper. |
| Oil Tempered MB Class 1 | .55 to .85 | A 229 | 310 KSI | 550 degrees 1 hour | Drawn to finish size and then hardened by heat treat or tempering process. Tempering |

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| | | | | | straightens wire and also improves operating temperatures. |
| Oil Tempered MB Class 2 | .55 to .85 | A 229 | 341 KSI | 550 degrees 1 hour | Use of higher carbon content allows higher tensile strength when compared to class 1 |
| Chrome Silicon | .51 to .59 | A 401 | 325 KSI | | Alloy additions of chrome and silicon increases operating temperatures. |
| Chrome Vanadium | .48 to .53 | A 231 | 315 KSI | | Very similar to Chrome Silicon. Demand on Chrome Vanadium decreasing as industry switches to Chrome Silicon. |
| Chrome Silicon Valve | .51 to .59 | A 877 | 328 KSI | | Mainly used in automotive industry. Valve quality requires improved surface characteristics and seam depth restrictions. Typically eddy current tested to verify surface conditions. |
| Chrome Vanadium Valve | .48 to .53 | A 232 | 315 KSI | | Again very similar to Chrome Silicon with demand diminishing. |
| Rocket Wire | .80 to .100 | None | 406 KSI | 450 degrees 1 hour | This is a higher tensile then Music wire developed by National Standard. Now produced only by Mt Joy. Higher carbon content used and drawn farther to gain tensile. |

**Why do springmakers request that coatings be applied to carbon spring wire?**
Unlike stainless steel coatings, carbon coatings typically serve a different purpose. Coatings on stainless i.e. soap and nickel coatings, are normally applied for lubrication purposes when the mill is drawing the wire and again for lubrication and formability during the spring coiling process.. On the other hand, coatings are applied to carbon wire normally to help improve the corrosion resistance.

**What coatings or plating are used on carbon wire for the spring making industry?**
Please reference the listing below for the various coatings or plating that are used on carbon wire for spring manufacturing.

- **Phos** is the most common coating for Music Wire and is a notable exception to the observation that coatings on carbon wire are applied to improve the corrosion resistance. The technical name is Zink Phosphate, which is very prevalent throughout the spring making industry, is generally applied to the wire by the mills to provide lubricity during the wire drawing process. Likewise, it is requested by springmakers to provide lubrication and easier formability at the spring coiler. It offers very little, if any, protection against corrosion. The Phos coating is applied by the mill during processing while the material is in a patented or soft state. The steel is subsequently drawn in soaps to the predetermined finished size much like soap coated stainless. **What is patenting?** Patenting is a heat treat process that softens the wire so that it can be drawn down to smaller diameters. The term patenting, essentially refers to a process that is very similar to

annealing in the production of stainless wire. These processing terms – i.e. patenting and annealing are used due to the heat treat characteristics being different for carbon vs. stainless steels.

So, in summary, Phos Music Wire is made up of a Zink Phosphate plating and drawings soaps. Is important to note that there are a couple of different types of drawing soaps that the various mills use when drawing Phos Music Wire. One is a calcium based soap, while the other is sodium stearate based soap. **What is the difference between a calcium based and a sodium stearate based soap?** Generally speaking the calcium based soap is more tenacious and provides better lubrication during the drawing process and at the spring coiler. Wire drawn through calcium soaps however, leaves soap residue on wire surface and thereby create a situation in which it may be a little more difficult to remove this residue . On the other hand, the aforementioned sodium sterate based coating is water soluble. It leaves less residue and therefore is easier to clean. **Is there a process wherein mills use oil rather then soap in their production process?** Some mills will wet draw, or draw through oil rather than soaps. This type of drawing practice is more prevalent with the foreign mills such as Kiss and DSR rather then domestic (Mt Joy) mills.

- **Corrostan** is the brand name for Mt Joy's galvanized coating. This is an electrogalvanized zinc plating that is put on the wire to improve the corrosion properties. The zinc is electronically deposited on the wire while the steel is in a soft condition or state, and is then drawn to the predetermined diameter (finished size). This process allows the zinc to adhere to the steel. It produces a very dull looking finish but comes with at 32 hour salt spray guarantee. This Corrostan plated material offers improved corrosion resistance over a Phos coated product, but nowhere close the corrosion resistance properties of stainless.. Corrostan can be manufactured by Mt. Joy in Music Wire and or MB Wire.
- **Preco Z** coating is a very similar product to Corrostan. It is produced by Suzuki in Japan. This is an excellent product that normally gets rave reviews from springmakers. It is more expensive than most coatings, but this material runs very well at the spring coiler. It too, is a drawn galvanized finish and has a rather dull appearance.. This material is only available in Music wire coils. Salt spray results are comparable to Corrostan.
- **Galvanized** coating is similar to Corrostan and Preco Z in that it is added to the carbon steel for improved corrosion resistance. Typically, Galvanized Music and/or Galvanized HDMB wire are specified when customers need increased corrosion resistance as compared to that offered by Phos Music Wire or Bright HDMB wire. **Is the processing of galvanized coatings the same method that is used to apply Corrostan or Preco Z?** No, it's worth noting that the mill's processing of a Galvanized finish is somewhat different than Corrostan or Preco Z. When springmakers specify Galvanized HDMB, the mill will process this as a hot dipped product that is normally applied when the material reaches its specified or finished diameter. For example, .156 Galvanized HDMB wire is drawn to the finished size and then during a final processing operation, it is single strand dipped in a tank containing a zink bath. Since the zink in this process will tend to build up and become lumpy the wire is then run through a series of wipes. This

wiping process smooths out the lumps. Please note that a hot dipped galvanized product is less expensive than a Corrostan or Preco Z product. Gibbs experience is that this final dip that is applied to the finished diameter produces a lower quality product , but the trade-off in cost may be worthwhile for some spring applications. The inherent problem is that springmakers sometimes encounter problems at their spring coilers due to flaking or coiling problems. The adherence characteristics of this hot dipped coating are not as good as those offered by drawn coatings like Preco Z and Corrostan. It is worth noting that Galvanized provides a much brighter finish then Preco Z or Corrostan. If a shinier galvanized finish is required, the hot dipped product may be considered. What is **DAG**? In certain sizes, the hot dipped galvanized can be re-drawn utilizing a couple of passes to smooth out the coating. This is typically called a DAG product. The DAG stands for drawn after galvanizing.

- **Tinned Finish:** The process of putting a tinned coating on wire is very similar to that of galvanized. It is a hot dipped product that is applied to the surface after the material is drawn to its specified diameter or finished size. It is run through a molten bath of tin and then, like galvanized materials, the wire goes through a series of wipes to remove the excess tin and smooth out the coating. Unlike galvanized, the tinned coating cannot be redrawn. It is worth noting that a tinned finish is not as common as it once was. The major benefit of this finish is cosmetic. It provides a bright lustrous finish. Corrosion resistance properties may offer a very slight improvement over Phos. A typical application for a tinned is music guitar strings, also known commonly as mandolin wire. This is essentially a tinned music wire.
- **Borax** is a less common coating, but is very prevalent for HDMB applications.. The borax is applied to during the drawing sequence at the mill. The process is very similar to that used for applying a Phos coating in that both are then drawn through soaps achieve to finished diameter. This coating is a little brighter than Phos. **Why do springmakers normally request a Phos coating on Music wire and a Borax coating on HD?** While Phos and Borax coatings are available on HD , the Phos coating would require a special order as typically 95% of what Gibbs stocks is Borax or a bright HD. Borax is a low-cost chemical than phos and wire draws better with the Borax coating. Mills typically use Borax when processing HD to keep the cost of this product lower than Phos Music Wire.
- **Oil Tempered** is not actually a coating, however, as noted earlier the tempering process is an additional step which performed when the wire is at its final diameter. This is a heat treat process that straightens the wire and increases its range of operating temperature applications. (Chrome Silicon and Chrome Vanadium wires are tempered products, as well.) Oil tempered can be supplied in a bright finish and or with a black finish. Black is most common and is what Gibbs typically carries in our inventory. The bright product is available, however. The bright finish is achieved by controlling the atmosphere in the tempering or processing tubes during the tempering operation.

4. **General Comments and other Information:** Basically, spring manufacturers do one or two things with wire. They either coil a spring or make some type of wire

form. There are basically three types of springs: compression springs, extension springs and torsion springs. The requirements of the application for the springs will typically determine the degree of difficulty that springmakers will face in producing the product.. For example, a spring that will be used in a child's toy will obviously be less demanding than a spring going into an automobile. Specifications and/or prints off in detail what the spring maker requires. Tighter ID's or OD's or the free length of the spring will demand better quality spring wire. **What is free length?** Springmakers sometimes encounter problems with wire because they see too much variation in free length. Essentially, the spring maker is attempting to control the free length of the spring within a specified tolerance , but is having problems maintaining the the tolerance.