Technically Speaking 24

Spring Materials, their specifications and microstructures

This will be the first of a short series of articles that examines the microstructure of spring materials, and at the same time will say something about their various international specifications. Future columns will deal with hardened and tempered steel and stainless steels, but the most commonly used spring material throughout the world is drawn carbon steel, and so this material will be the subject of this column. That is to say, carbon steel that has been produced with a microstructure of pearlite, and which has been work hardened (cold) by wire drawing or strip rolling to produce spring properties. When pearlitic carbon steel has been drawn to a relatively high strength, the wire is often referred to as piano or music wire. This name derives from one of the first uses of the wire.

Drawn carbon steel may be supplied against ASTM A227 or A228, EN10270-1, JIS G3521 or G3522, BS 4637 and many other specifications, all of which are very similar. In other words this type of wire is used in every country of the world. The specifications give lots of useful information, but in this column attention will be focussed on some of the things not mentioned. The first is the microstructure, which has the appearance shown in figures 1 and 2.

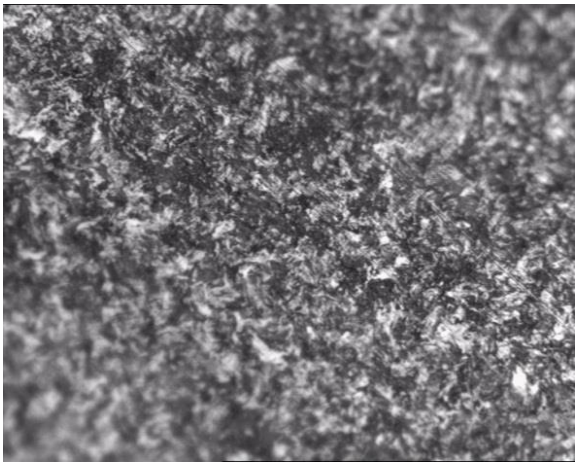

Figure 1 Transverse section x440

Figure 2 Longitudinal section x440

The heavily elongated nature of the microstructure can only be seen in the longitudinal section, but at the limits of resolution of metallurgical microscopes the details of the pearlitic structure are not resolvable. This applies whether or not the pearlite was formed, prior to drawing, by air or Stelmor cooling after rod rolling or by lead patenting by the wire drawer. Most specifications do not stipulate the means by which the pearlite should be formed, and sometimes the microstructures are indistinguishable from these two process routes. However the air cooling route usually results in a small proportion of free ferrite being resolvable. Many commentators have asserted that the lead patented microstructure is better and that springs made from this material will outperform those of air cooling origin. However, they are less forthcoming with a quantification of the difference, and this is because the difference is often too small to measure with statistical confidence.

Drawn carbon steel is often described as having a phosphated coating. The phosphate process is carried out prior to drawing and so the phosphate structure is thoroughly obliterated during drawing. The description is, nonetheless, correct, but the supply certificate with this type of wire seldom mentions the soap that is used to lubricate the wire drawing – the phosphate is the carrier for the soap lubrication. The soap is always left on the surface of spring wire as this residual coating lubricates the spring coiling process.

Some drawn carbon steel is drawn after it has been galvanised – a process of dipping the wire in a bath of liquid metal after the final heat treatment to produce pearlite. Wire with this

galvanised (or Zn/Al coating) coat is cold drawn to produce spring properties as described above. The microstructure of the product is as shown in figures 3 and 4.

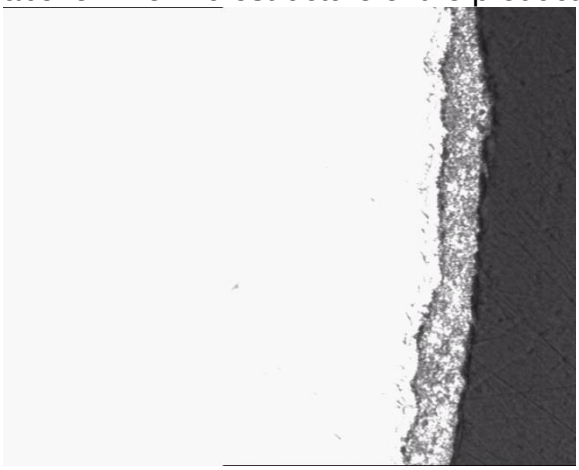

Figure 3 Trans. section of galv. coat

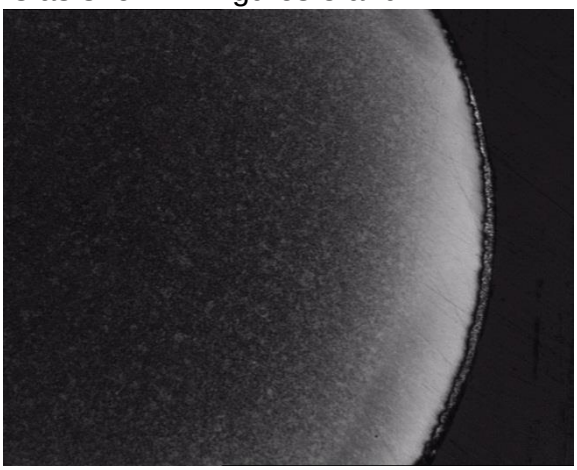

Figure 4 Trans. Section of coating

In figure 3 the two layers of the galvanised coating (Fe/Zn layer and pure Zn on top) are just visible. In figure 4 the slightly non concentric nature of the coat can be seen, as can the way the zinc has stopped the microstructure near to the wire surface being etched. The zinc coating has sacrificed itself in a corrosion reaction (etching) to protect the underlying steel – exactly the purpose of the galvanised coat on carbon steel wire.

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Readers are encouraged to contact him with comments about this technically speaking column, and with subjects that they would like to be addressed in future.
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