

## Cautionary Tale XXXX Shot Peening

Shot Peening is a process used by the spring industry that brings significant benefits to spring performance. It is a process that is not always fully understood by springmakers – they usually know that the process improves the fatigue resistance of the springs they make, but do not always fully understand the mechanism behind this improvement. The purpose of this cautionary tale is to explain some of the theory behind shot peening of compression springs, which will help springmakers and their customers understand the process and the benefits it brings.

Shot peening of compression springs is a process that involves bombarding the whole surface of the spring with very many particles of rounded shot. These impacts from the shot are so numerous that at least 80% of the spring surface is covered with small dents – often 90 or 100% coverage is specified, but IST recommend that 80% is the absolute minimum that will be effective. Each impact produces a small dent and around that dent there will be a layer of material that has been work hardened by the impact and a deeper layer that has a residual compressive stress. After shot peening, the benefits accrued are:

- a) The spring surface is harder (stronger)
- b) The original wire surface is smoother with the original wire drawing marks being largely obliterated.
- c) There will be a residual compressive stress on the inside surface of the compression spring where the applied stress in service will be a maximum.

All three of these benefits will contribute to the improvement in fatigue performance, but it is the last, the generation of a residual compressive stress, that is the most important by far. It should be the strategy of spring manufacturers to maximise the residual stress, but this presents a problem to most because they have no machine for measuring this parameter in the springs theypeen. Manufacturers of engine valve springs will probably have the X-ray equipment necessary for measuring residual stress, but if you don't make these very high performance springs then you won't.

You probably will have the means to measure the intensity of your shot peening using Almen strips. If the shot you use is between 2 and 20% of the spring wire diameter, then the higher the Almen arc rise the better the peening will be. However, there is a possibility of over-peening using this clumsy approach to optimising your process. Over-peening is not a disaster in as much as spring performance will always be better with over-peening than with no peening at all. However some buyers of springs are concerned about over-peening particularly when the company's metallurgist has found laps and a white layer at the surface of shot peened spring as shown in the two photographs. Figure 1 shows the white layer and a shallow lap, and figure 2 shows a lap.

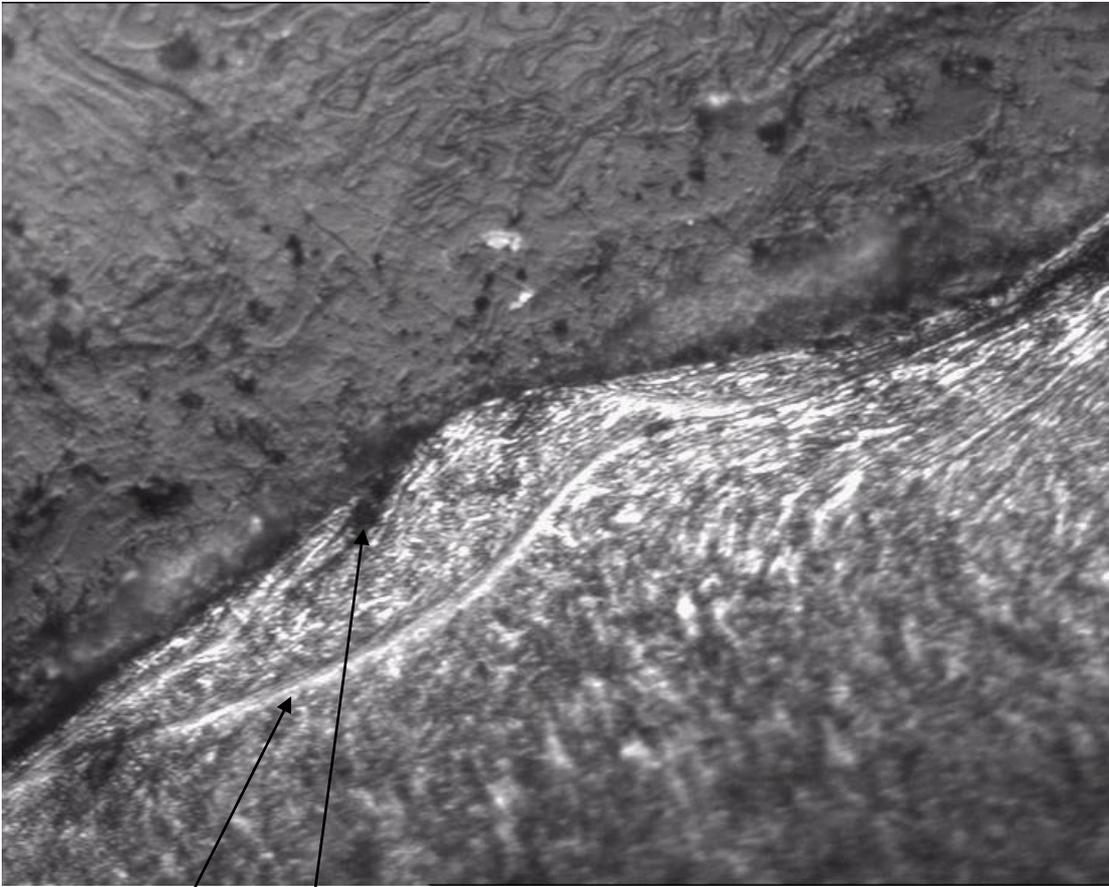


Figure 1 White lines and lap due to shot peening

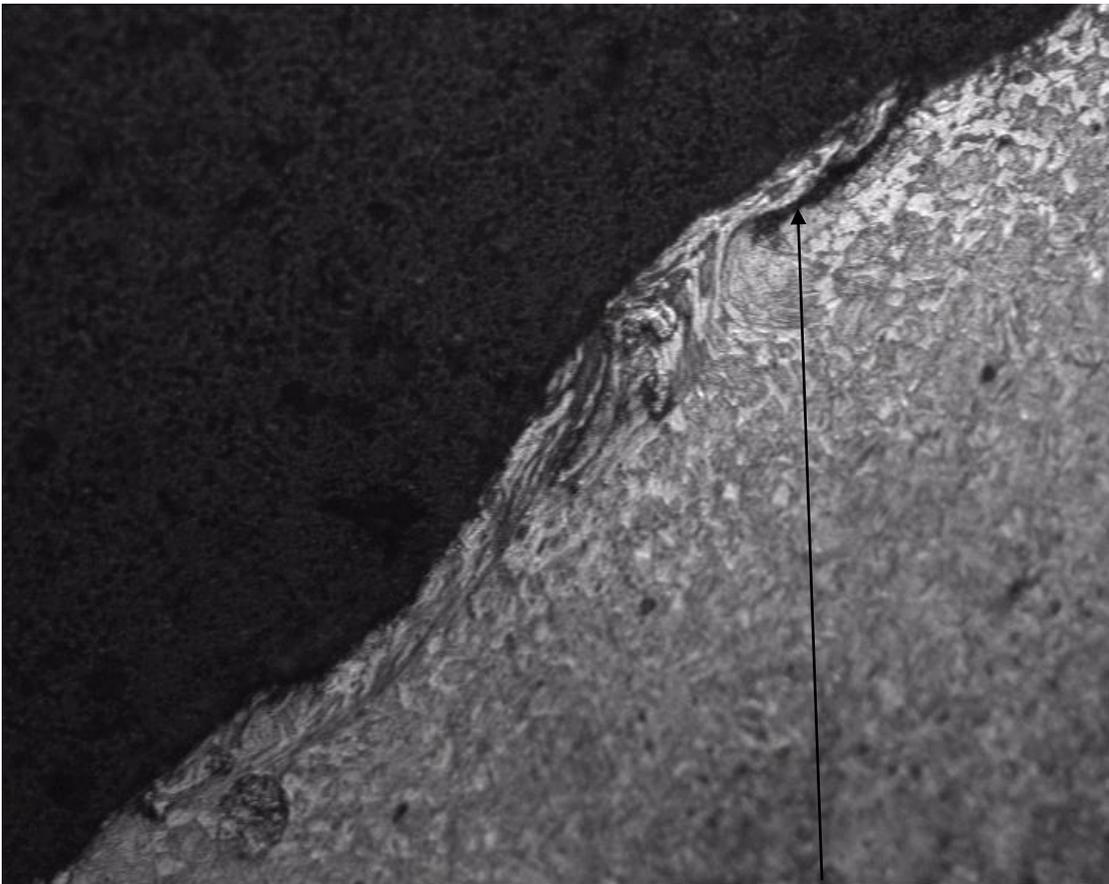


Figure 2 cold working of the spring surface due to shot peening and lap

Would your customer be worried by the shot peening shown in the photographs? A recent enquirer to IST asked whether the white layer was friction martensite? Another asked if the damage shown in figure 2 was excessive?

The answer to these very reasonable questions was that the performance of the springs that were photographed above was satisfactory, so you should not be particularly worried by this appearance. The white layer is due to work hardening and is not friction martensite (which would be a disaster if present). Laps are inevitable with good shot peening and if the depth is less than 5 microns for cold formed and 10 microns for hot formed springs that they probably don't matter. Reassured? I hope so, but there are several other cautionary tales that the author could write on this subject if there is sufficient interest.

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*Readers are encouraged to contact him with comments about this cautionary tale, and with subjects that they would like to be addressed in future tales, by telephone at (011) 44 114 252 7984, fax (011) 44 114 2527997 or e-mail [m.hayes@ist.org.uk](mailto:m.hayes@ist.org.uk).*

