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Dual Peening

DUAL PEENING is used to further enhance the performance of traditional shot peening. Whereas traditional shot peening uses one shot media at a specified intensity range, dual peening adds a secondary shot peening operation. The second peening operation usually uses a smaller diameter media that is peened at a lower intensity than the first peening operation. When the secondary peening is performed, the smaller media is able to pound the high points from the first shot peen into the surface. This has the effect of driving additional residual compressive stress at the outer surface.

Figure 1 shows a magnified view of a single peen using 230H shot media.

Figure 2 shows the same magnification of a dual peen of the same surface. The original 230H shot peening operation has been followed by a 110H shot peening operation. This surface shows a better surface finish as a result of the peaks from the 230H shot peening being pounded in the surface.

Figure 3 shows the effect of greater residual compressive stress at the surface of a carburized gear from the dual peen (solid line).

Since almost all fatigue cracks initiate at a component's surface, the residual compressive stress in the near-surface region (up to 0.002" depth) is very important. Readers of *The Shot Peener* magazine are aware that applications that operate in higher cycle (lower stress) fatigue regimes respond better to shot peening. Therefore, if a single peen operation moves the component into a higher cycle fatigue regime, the second peen is able to further expand the benefits of first peen.

There are two common reasons to dual peen. In some industries, such as Formula One or NASCAR racing and medical implant manufacturing, it is common to 'pay up' for performance. Therefore, design engineers in these industries will often ask for the best peening process with less concern about cost.

The second reason is increased performance demands to existing parts. It is not unusual for either loads to be increased or life requirements to be lengthened. When the fatigue performance demands outgrow the initial peening requirements, it is likely that the lowest cost improvement to the part is to add a dual peen to the part in the assembly that fails (providing that it is already shot peened). For example, an engine manufacturer had recently uprated the horsepower output going to the transmission. Accelerated engine load testing was failing on a carburized and shot peened transmission gear at 19 hours of testing. The design engineers required 50 hours of testing to validate the engine and transmission for release. By changing the original shot

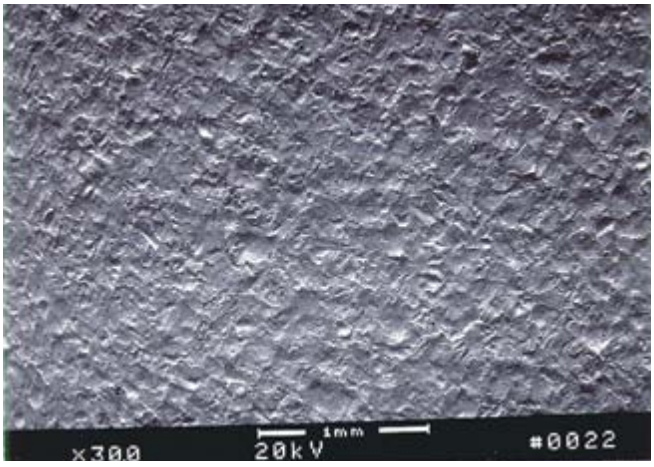

Figure 1. Single peen using 230H shot media

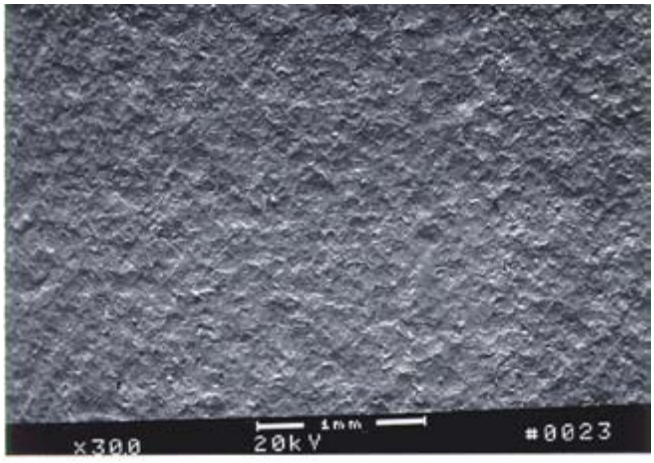

Figure 2. Dual peen using 230 H media, followed by 110H peen

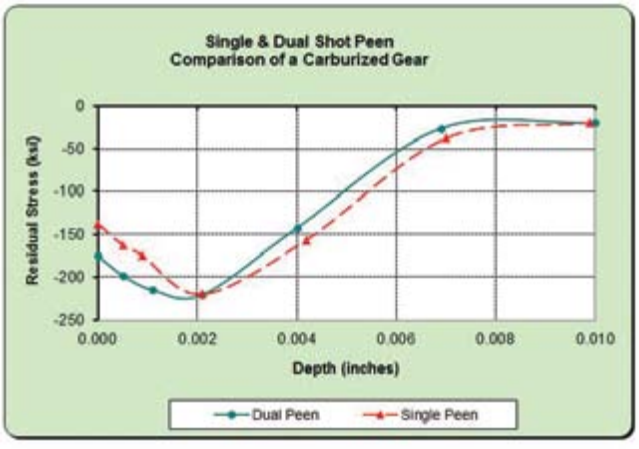

Figure 3. Single and Dual Shot Peen Comparison of a Carburized Gear

peen operation to a dual peen, the engine and transmission reached 50 hours of accelerated testing thus allowing the engine design for release.

The most common dual peening callouts usually have a larger steel shot followed by a smaller steel shot. An example is the following 330H-110H dual peen callout.

1st shot peen: 330H @ 0.016-0.020" A, 125% coverage
2nd shot peen: 110H @ 0.005-0.008" A, 125 % coverage

Some variations of a dual peen use a different media material for the second peen. It could be non-ferrous such as glass bead or ceramic media. When shot peening case-carburized gears, the benefit of using glass or ceramic is both medias are harder than traditional hard shot peening media (55-62 HRc) and the case-carburized surface (58-63 HRc).

Two benefits happen when using this type of dual peen on carburized gears, especially those that have the tooth flanks ground.

- The residual compressive stress and maximum compressive stress (from the first shot peen) is increased from the surface to about 0.002" depth. This happens because the glass/ceramic media is harder than the carburized surface (as opposed to being about the same hardness of the steel media). Higher values of residual compressive stress are produced thus offering better fatigue performance as this is where fatigue cracks initiate.
- The surface finish achieved from the first shot peen is improved resulting in a more refined surface finish. This reduces localized contact stresses from the rolling and sliding forces on mating gear tooth faces. Tooth flank failures from these mechanisms are a major cause of concern for gear engineers. It is accepted that a better surface finish on gear tooth flanks generally results in improved gear life.

Figure 4

Figure 4 shows the improvement in surface finish on a (35 HRc) steel component that was first shot peened with a 230H media around the face of the bore. Half of the bore face was then masked and the other portion had a secondary glass bead peen applied with a 0.006" Ø glass bead. Residual stress analysis was not performed on these surfaces but it is a safe assumption that the dual peened surface would have additional residual compressive stress at the surface.

When evaluating options to address fatigue failures, shot peening is usually considered along with changing materials, geometry and heat treatment. When evaluating options on a fatigue failure of a shot peened component, a dual peen should always be considered. No additional vendors have to be added to the manufacturing and some of the shot peening process steps (i.e., masking) do not have to be duplicated. This makes dual peening an attractive option from both a cost and manufacturing standpoint.

About the Author: Dave Breuer has worked with Metal Improvement Company (MIC), a business unit of Curtiss-Wright Surface Technologies, for over sixteen years. Mr. Breuer is the primary author of MIC's "Shot Peening Applications-Ninth Edition," a widely distributed international publication.