CNC-DEEPHARDENING® VERSUS NITRIDE

THE COLD HARD TRUTH!

Introduction

Due to improvements in quality and durability, press brake tooling is no longer a perishable commodity. When properly cared for and used within the correct range of applications, today's precision ground and hardened press brake tooling can often provide a usable service life of ten years or more. That it not to say that it will simply last for ten years or more, but rather, it will provide performance that is the same or nearly the same as it did when it was brand new and right out of the box for that
long or longer.

This is certainly not true of all press brake tooling. It is true however of high quality precision ground and hardened press brake tooling. As such, when purchasing tooling for a new press brake, today's press brake buyer is now more than ever making a long term decision. And as with any other long term business decision, you'll want to make the decision that will provide you with maximum productivity and the maximum return on your investment. In this document, we compare the proprietary CNC-Deephardening® process developed and applied by WILA to our state of the art New Standard tooling system and our American tooling system, to the Nitride or Nitriding process as it is often referred to, that is used by some of our competitors.

1. CNC-Deephardening®

Research has proven that, in order to maintain consistent part to part accuracy and long term quality, punches and dies must be hardened to a minimum of HRC-54 on the surfaces that engage the material during the bending process. The depth of the hardened area must also exceed the total depth in which the tool comes under stress during the bending process (see section 4). The CNC-Deephardening® process developed by WILA, is a tight tolerance, CNC controlled induction hardening process. This process provides a highly refined and therefore highly consistent hardness layer in terms of the level of hardness and the depth of hardness across the entire heat treated area. It is also exceptionally repeatable from tool to tool. During the CNC-Deephardening® process, heat is applied to the steel via an electric current that runs through a copper electrode. The hardness of the outer structure of the steel is raised to a level that is significantly harder than the base material. The base material retains a core hardness level of HRC-30, while the outer structure is hardened to a minimal hardness of HRC-56 to a minimum depth of .118" (3.0mm) and a maximum depth of .197" (5.0mm). Figure 1 provides an example of the depth of hardening that is obtained through the application of WILA's CNC-Deephardening® process.

Figure 1. Photograph shows die with WILA proprietary CNC-Deephardened® process applied.

2. THE NITRIDE OR NITRIDING PROCESS

The Nitride or Nitriding process is used to introduce Nitride particles to the steel. This is accomplished by heating the material in a Nitride rich environment. Aluminum is used to bond the Nitride particles to the base material. This process creates Aluminum-Nitride (AIN) which deposits Aluminum in the substrate material. Aluminum-Nitride (AIN) is a ceramic like material and is therefore much harder than the substrate material, which normally is approximately HRC-35. This results in a thin and brittle hardness zone that is approximately .020” (0.5mm) deep at a hardness level of HRC-70. Figure 2 provides an example of the depth of hardening that is obtained through the application of the Nitride or Nitriding process.

During the Nitride or Nitriding process, Aluminum-Nitride (AIN) particles are deposited between the grains of the steel. This results in a marked decrease in the toughness and impact strength of the hardened zone (see Figure 3). While there are several forms of the Nitride or Nitriding process, the process described above is the only one that is known to be used in the manufacture of press brake tooling as of the date of this publication.

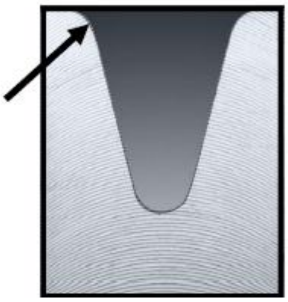

Figure 2. Photograph shows die with competitors Nitride process applied. Note the extremely shallow hardness zone.

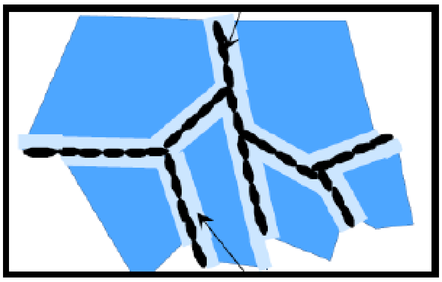

Figure 3. Illustration shows position of AIN particles and the depth of hardening provided by Nitride process.

3. THE NEGATIVE EFFECTS OF A THIN HARDNESS ZONE

Applying a thin layer of Nitride to a relatively soft substrate material actually has a negative effect on the strength of the material. A simple comparison is that of the egg, which has a hard shell and a soft core. When pressure is applied to the outside of an egg, it causes elastic deformation of the soft core as well as deformation of the shell. The hard shell has nothing to support it from beneath and is therefore unable to withstand the deformation. Eventually, it will break and separate from the soft core. During the bending process, as pressure increases on the punch tip, stresses develop at both the punch tip and within the core of the punch (see Figure 4). Stress levels are always highest on the outer surface of the tool. When the tool is encased in a Nitride coating, the thin layer of Nitride may suddenly separate from the soft core of the tool as with the example of the egg. When this happens, the sudden change in the hardness of the material can exaggerate this effect (see Figure 5). In extreme cases, it may cause the tool to shatter, sending fragments of the tool flying at high velocities. This of course can result in serious injury to both the press brake operator and others within the immediate area of the press brake. As with all forms of induction hardening, WILA’s CNC-Deephardening process does not produce a thin brittle layer around the outside of the tool. Therefore, this problem will not occur when using tooling that is hardened with this process.

4. HERTZ THEORY OF STRESS & THE DEPTH OF MAXIMUM STRESS LEVELS

The Hertz Theory of Stress states that during bending, maximum stress levels occur below the surface at about 0.8 times the width of the contact surface of the punch tip radius and the top surface of the material being bent. When bending with pressures of 33 tons per foot (100 tons per meter) or more, maximum stress levels occur at .008" (0.2mm) below the surface of the punch tip, and likewise at .008" (0.2mm) below the top of the material. Maximum stress levels should always occur at well within the hardened layer of the punch. Otherwise, the difference in the deformation between the substrate material and the hardened layer will cause the hardened layer to separate from the substrate material as described in section 3. Figure 5 shows the results as measured in the depth of hardness of a press brake tool that has been coated with Nitride versus a tool that has been CNC-Deephardened®. The results clearly demonstrate that the maximum stress levels described above occur well within the CNC-Deephardened® layer. However, in the case of the Nitride coated tool, maximum stress levels occur below the hardened layer or in the area where the hardened area transitions to the softer substrate material. This will promote the separation of the hardened layer of the tool from the substrate material as described in section 3.

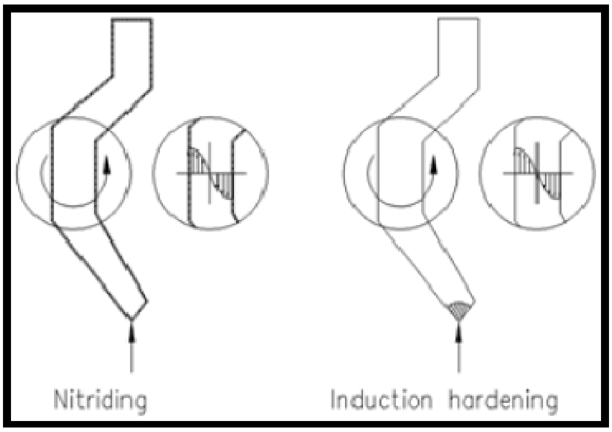

Figure 4. Illustration shows the stresses that develop within a punch during a typical bending cycle, with both the Nitride (Nitriding) and the CNC-Deephardening® (Induction hardening) processes applied.

5. MEASUREMENT RESULTS & THE HARDNESS TRAVERSES

The highly renowned Dutch materials testing company, Stork FDO (www.storkmt.com), measured the hardness of a press brake tool hardened with WILA's CNC-Deephardening® process, and another tool hardened with the Nitride or Nitriding process. For both tools, a micro-hardness traverse was made using the Vickers 0.2 method. Most information pertaining to hardness levels involving press brake tooling is expressed in HRC (Rockwell C-scale) values. However, it is impossible to measure the hardness of a tool that was treated with the Nitride or Nitriding process in HRC due to the thin Nitride layer. Figure 5 provides the results of the measurements as measured with the Vickers 0.2 method. The results obtained with the Vickers 0.2 method were converted to HRC values to provide the reader with the form of measurement that is most commonly used with press brake tooling. Figure 6 provides the results of this conversion. However, it is also technically impossible to measure the surface hardness of the CNC-Deephardened® tool as the Vickers method measures the hardness at .008" (0.2mm) below the surface. In Figures 5 and 6, the theoretical surface hardness values are shown.

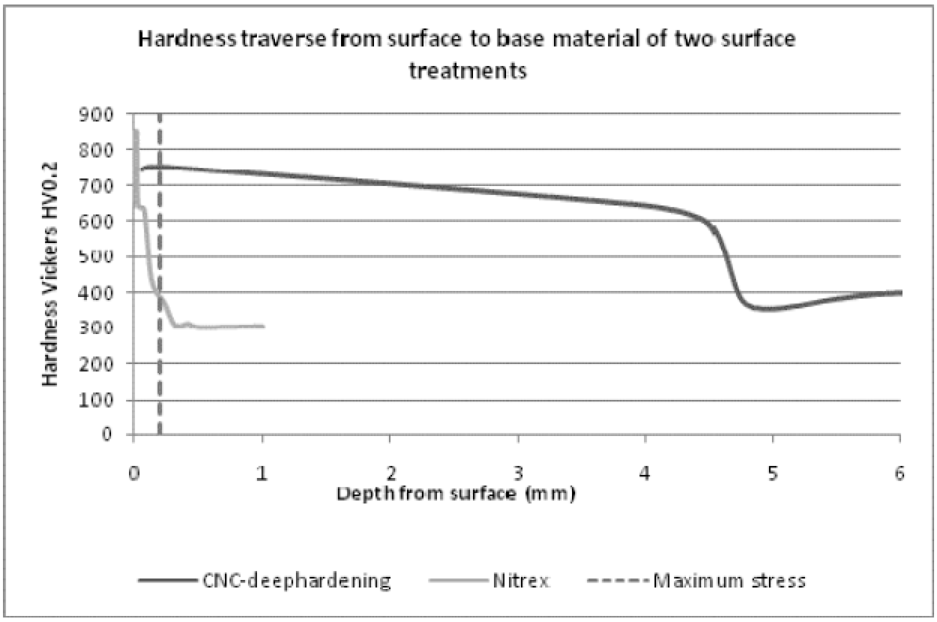

Figure 5. Graph shows the hardness zone as a function of the depth from the surface. Notice the sharp drop off in the depth of hardness provided by the Nitride (Nitrex) process as indicated by the light gray line, most of which occurs within the maximum stress zone.

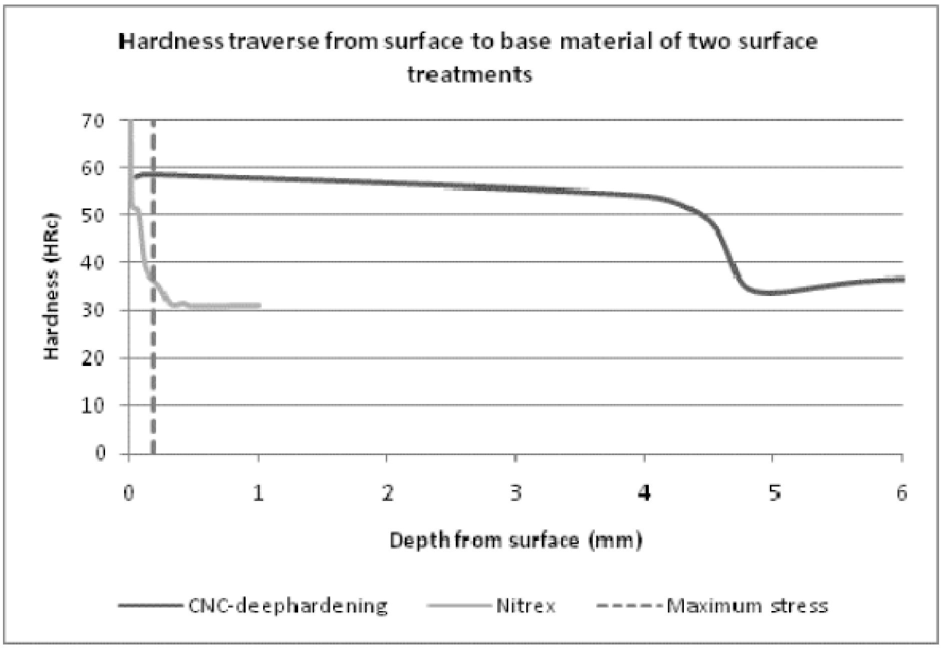

Figure 6. Results as measured in figure 5 converted to HRC – (Rockwell C-scale) values.

6. MAGNIFIED IMAGES OF CNC-DEEP HARDENING PROCESS

The following photographs provide a visual representation of the properties obtained through the application of WILA's proprietary CNC-Deephardening® process.

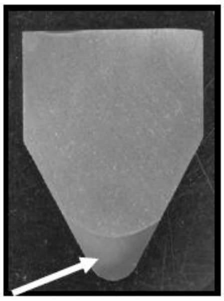

Figure 7. The CNC-Deephardened® area of this WILA punch is clearly visible at 2x magnification.

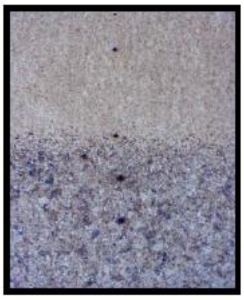

Figure 8. Magnification of 100x shows the transition from the CNC Deephardened® area (light color) to the base material

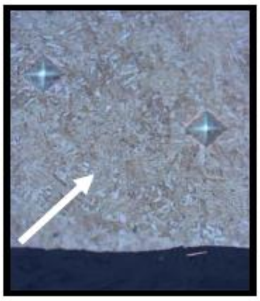

Figure 9. Magnification of 250x shows details and depth of hardness zone. The two diamonds indicate where hardness measurements were taken.

7. MAGNIFIED IMAGES OF NITRIDE (NITRIDING) PROCESS

The following photographs provide a visual representation of the properties obtained through the application of the Nitride or Nitriding process.

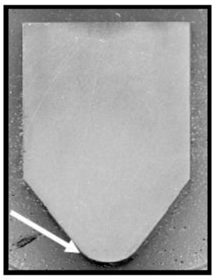

Figure 10. Even under a magnification of 2x, the thin hardness zone provided by the Nitride process can only barely be seen.

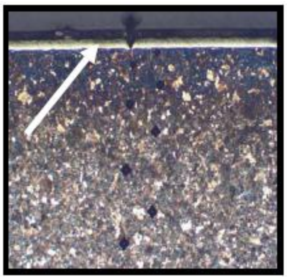

Figure 11. Magnification of 100x. The white layer is a typical layer of Nitrided material. The black diamonds indicate where hardness measurements were taken.

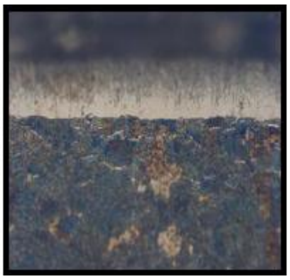

Figure 12.Magnification of 500x shows the detail of the Nitrided layer. The typical white layer can be seen along with the small white vanes below the white Nitrided layer.

8. THREE CRITICAL POINTS OF PRESS BRAKE PRODUCTIVITY

In today's environment of precision air bending and CNC controlled press brakes, accuracy along the Tx and Ty axis is determined by the accuracy of three critical points, the punch tip radius and the die shoulder radii (see Figure 13). Aside from the back gauge, these are the only points that will ever come in contact with the material. As such, the durability of these points is vital to productivity. And this is true when bending light gauge materials (see Figure 14) all the way through heavy thick plate materials (see Figure 15). Getting the maximum return on your press brake tooling investment depends upon utilizing press brake tooling that is designed to provide maximum wear resistance.

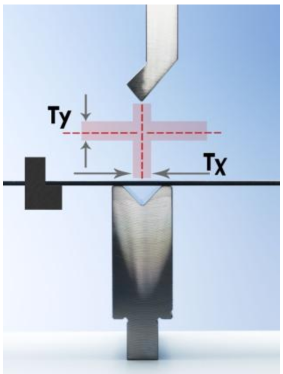

Figure 13. Illustration shows the three critical points (punch tip and die shoulder radii) that determine finished part accuracy along the Tx and Ty axis.

Figure 14. Photograph shows a precision air bending application where the slightest inaccuracy along the Ty axis can result in an angular error of several degrees.

Figure 15. Photograph shows a heavy plate bending application. While often overlooked, the need for hardened tooling is greatest when bending thick abrasive, plate materials.

9. SUMMARY

Now that you've seen both the visual and the scientific evidence, we're confident that you will agree that not all press brake tooling is created equal. This includes such important features as the accuracy, speed of setup, flexibility, and as demonstrated in this document, the heat treating process that provides its durability.
Insist on the maximum return on your press brake tooling investment. Demand WILA press brake tooling!
The only tooling that comes with WILA's proprietary CNC-Deephardening® process.