

# Deep Drawing Stainless Steel

## IS IT REALLY DIFFICULT OR JUST DIFFERENT?

*Peter J. Ulintz, Manager of Advanced Product Engineering  
Anchor Manufacturing Group, Inc.*

### **Why is Stainless Steel Different?**

Stainless steels are iron-based alloys containing more than 10.5% chromium. The chromium in the steel reacts naturally with oxygen in the air to create a passive chromium-oxide ( $\text{Cr}_2\text{O}_3$ ) film on the surface of the steel. (The term *passive*, simplified, means the surface no longer reacts chemically to its surrounding environment). It is this passive film to which stainless steels owe their superior corrosion resistance. Even though this layer is thin, it does raise the level of friction between the tool and the work piece, which leads to galling and wearing of the tool surface.

There are two groups of stainless steels commonly used to deep draw products, these steels are classified in the austenetic and ferritic groups. Type 200 series and Type 300 series identify *the austenetic group*. Type 304 and 316 are the most widely used grades in the austenetic group<sup>1</sup>. Type 400 series identifies *the ferritic group*, although there are some martensitic stainless steels within the 400 series as well. Type 430 is the general-purpose stainless steel of the ferritic group<sup>2</sup>. Both ferritic and austenetic stainless steels work harden at faster rates than carbon steels; therefore, it requires higher pressures to form stainless steel than it does to form carbon steel of the same thickness and temper.

The combination of high forming pressures and surface friction results in significantly higher tool wear rates than those used to form carbon steels. These higher wear rates lead to significant increases in tool maintenance, downtime and production costs. As a result, proper tool coatings and lubricants must be used in order to improve tool performance.

Stainless steel must also be handled with great care, especially in areas where carbon steels are also being processed, to avoid iron contamination of the stainless steel surface. Any iron contaminants left on the stainless steel surface will lead to red rust – which, is the iron oxidizing on the stainless steel surface.

### **Tool Coatings**

The most important thing to remember about tool coatings (either PVD or CVD) is that one coating cannot solve every application. Therefore, careful consideration of a number of factors must be made before selecting a tool coating for a particular application.

---

<sup>1</sup> Specialty Steel Industry of the United States, Designer Handbook - Stainless Steel Fabrication

<sup>2</sup> Specialty Steel Industry of the United States, Designer Handbook - Stainless Steel Fabrication

The primary purpose of adding a tool coating is to reduce the coefficient of friction between the tool and the work piece. However, these coatings are not inherently lubricious in nature and cannot be expected to eliminate or replace lubricants.

Below are some tool coating recommendations based on historical performance data<sup>3</sup> for forming and stamping stainless steel:

*Piercing, Cutting & Blanking:*

Good Choice for general working conditions: TiN, TiCN, CVDTiC/TiN  
Best Choice for severe conditions: CVD TiC, MoST<sup>TM</sup>

*Drawing, Forming & Flanging:*

Good Choice for general working conditions: CVD TiC/TiN, TiCN, T-D  
Best Choice for severe conditions: CVD TiC, MoST<sup>TM</sup>

MoST<sup>TM</sup> is a registered Trade Mark of MultiArc, Inc., Rockaway, New Jersey

**Lubrication**

Lubricants used to cut and form stainless steel require high film strengths, which actually places a mechanical barrier between the tool and the work piece to prevent metal-to-metal contact. High film strengths are achieved by using lubricants containing hydrocarbons, polymers, wetting agents and extreme pressure agents.

The surfaces of most stainless steels do not retain lubricants as readily as other metal surfaces. For this reason, emulsion-type lubricants with super wetting characteristics have been formulated for stainless steels. Heavy-duty evaporating compounds (remember, evaporation promotes cooling) containing extreme pressure agents have good anti-wipe properties.

**Passivation of Stainless Steel**

The chromium-oxide (Cr<sub>2</sub>O<sub>3</sub>) film on the surface of stainless steels will form spontaneously, or repair itself, both in air due to the presence of oxygen or oxidizing elements. The basic passivation treatment for stainless steel is exposure of a clean surface to air. However, there is much evidence that shows that passivity, and therefore corrosion resistance, is enhanced if the passive film is formed by the action of oxidizing solutions<sup>4</sup>. Nitric acid is such an oxidizing acid, and is always used for passivation treatments. Nitric acid passivation is most useful in enhancing the corrosion resistance of freshly machined surfaces.

---

<sup>3</sup> B. Janos, Multi-Arc, Inc., PVD/CVD Coatings for Stamping and Forming Stainless Steels, FABTECH International 1998 Conference Proceedings, (pp 1-2)

<sup>4</sup> Specialty Steel Industry of the United States, Designer Handbook - Stainless Steel Fabrication

## Avoiding Contamination Problems

Sometimes the appearance of rust streaks on stainless steel leads to the belief that the stainless steel is rusting. Look for the source of the rust in some iron or steel not actually part of the stainless steel itself. Steel (ferrous) contamination can be minimized by the use of stainless steel wire brushes and grinding with abrasives that have not been used on carbon steel.

**Contamination arises mainly from the surface of equipment, which have previously been used in contact with carbon (mild) steel.** Iron contamination can be caused by (1) coil feed equipment, or other machine surfaces, which were not thoroughly cleaned prior to processing the stainless steel, (2) producing parts in tooling that also processes plain carbon steel, (3) cleaning parts in solutions used to clean plain carbon steel, (4) handling stainless steel coils with steel chains, (5) sharing material handling equipment between plain carbon steel and stainless steel, etc.

All handling and processing equipment should be cleaned prior to use with stainless steel. It is advisable to plan and schedule the handling of stainless steel, because if handling is done on a random basis, this cleaning is often neglected and contamination results. While it is not always possible to have handling equipment dedicated for use with stainless steel, this should be done whenever possible.

## Conclusion

Forming, fabricating and deep drawing practices used for carbon steels, aluminum and copper are the same ones used for stainless steels. Therefore, the processes involved with forming stainless steels really are NOT DIFFICULT. However, due to higher strengths, friction coefficients and surface abrasion of stainless steel sheet, the process is DIFFERENT.

It is important to remember that the higher strength of stainless steels requires more pressing power and produces more springback. The formability of stainless steels is less than plain low carbon steels and HSLA steels due to rapid work hardening as they are cold worked. Furthermore, because of the abrasive surface topography of stainless steel, interface friction between the sheet and tool can be quite high. This causes high friction conditions and much heat is generated during the forming process. This will require different selection criteria for tool steel coating and lubrication selection. The final consideration for metal stampers who supply both plain carbon steel and stainless steel products, is to avoid contamination problems in the press shop.

With proper planning, processing and understanding how to form stainless steel products, one soon begins to realize, “it’s not difficult – just different!”