The trend in metal stamping is to use more and more aluminum and other lightweight materials, such as advanced high strength steel (AHSS). The need for technology to help improve metal flow of these materials in deep-drawing applications also is increasing. In many cases, a stamper's original tooling was designed and built to produce steel parts. A switch to softer material such as aluminum or stiffer material such as high-strength steel causes a significant increase in draw failure, demand on the tool, and the potential for parts that do not meet specifications. Ideally, the tooling should be modified to accommodate the forming and stretching characteristics of these new materials, but the expenditure is not always in the budget.

Stretching aluminum around tight radii requires the use of a lubricant that can provide a consistent film barrier and reduce friction. High-strength material demands a lubricant that provides the required film strength under increased pressure and frictional heat.

New Lubricant Requirements  Traditional oil-based lubricants designed for deep drawing regular-strength steel react with the iron content of steel and the heat generated during the forming process to create a chemical barrier film. Extreme-pressure (EP) additives such as sulfur or chlorine protect the steel during the drawing process, while the oil provides slip.

This type of lubricant is not as effective on aluminum because of that material's minimal iron content and other metallurgical properties. The slip generated by the oil provides some alloy flow assistance, but not the physical barrier necessary to prevent hang-ups or thinning in tight areas. A lubricant that provides a physical barrier film prevents the aluminum from actually coming in contact with the tool, thus preventing radius hang-ups and fractures.

With high-strength steel, the increased heat and pressure break down the oil viscosity of EP lubricants and their ability to protect. The physical barrier created by high-solids polymer (HSP) lubricants holds up under heat and pressure, protecting the metal from galling and thinning, which can cause break out failure.

Aluminum Formability  An aluminum manufacturer studied the forming effect of lubricants on aluminum sheet used in deep-draw applications at the company's technical center and in the field. The technical center tests measured the forming depth limits of traditional straight-oil lubricants and HSP lubricants using a 2.75-in. by 5.75-in. raised cross draw die. The test consisted of drawing 0.031-in. aluminum sheet until fracture. The results ranged from 0.47 in. to 0.73 in. in depth, with HSP providing 40 to 55 percent greater depth capability (Figure 1).

Field tests produced similar results. Using HSP lubricant on a Dodge Dakota® tailgate made from 5000 series aluminum sheet reduced the scrap rate from 40 percent to less than 1 percent (Figure 2).
In another test, drawing of an aluminum cross member proved that the material could be stretched 40 percent more than the material’s specified forming range using an HSP lubricant. As one of the test engineers stated, “The material is stretching past the boundaries. The intended max is 15 percent; it’s stretching 19 percent because of the lubricant.”

**Tests On High-Strength Steel** Greenleaf Technologies’ lab recently compared the forming effects of an HSP lubricant with standard automotive industry-approved drawing oils and synthetics on U.S. Steel’s DP780 AHSS. The Ohio State University-developed Interlaken stretch forming test method was used. This method has been proven to correlate well with actual product results. The results showed that an HSP lubricant with a value of 145 allowed the metal to stretch about 25 percent more than the automotive industry-approved oil and synthetic lubricants with values of 115 and 110, respectively. The greater the value of the lubricant, the better the formability\(^3\) (Figure 3).

HSP lubricants can cost up to two times more than conventional lubricants. However this increase can be a fraction of the savings from reduced scrap.

**A Viable Option** With the metal forming industry in great need of improving productivity and reducing cost through reduced scrap, downtime, and material costs, thinking outside the box when it comes to metal formability and the influence of lubricant is paramount. The average metal forming company spends 75 percent of its operating cost on metal and overhead. If tooling upgrades can be avoided or lost productivity reduced through a lubricant change, companies will have a new tool for achieving profitability as newer materials create greater demands.

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**Footnotes:**
2. Field study conducted by Alumax, Jan. 1998.
3. Advanced High Strength Steel (AHSS) study conducted by Greenleaf Technologies’ lab, June 2003