Warming Up To Cold Forming

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New product development (NPD) teams are always looking for a competitive edge that will allow them to make their electronic devices smaller, appliances more reliable, vehicles safer, or instruments more precise. These products often call for highly engineered metal components on an increasingly miniaturized scale, and the demand for these miniature and micro metal components is accelerating. Those developing such products have a variety of choices in sourcing these components, seeking to meet critical functional specifications without compromise to design for manufacture (DFM), design for assembly (DFA), quality and cost.

Weighing the available processes against one another according to cost-benefit criteria by which they are typically assessed brings to the forefront one process that is often overlooked.

Cold forging, or cold forming, is the application of force with a punch to a metal blank staged in a die. The force exceeds the alloy's elastic limit, causing plastic flow until the metal blank assumes the shape bound by the punch and the die. As the name implies, this method of forming is achieved by force alone, forgoing the application of additional heat or cutting and shearing. Consequently, cold forming does not re-anneal or mechanically damage the material's original metallurgical grain structure like other processes can.

Consider the advantages and disadvantages highlighted in the accompanying table. Following the table are three examples of cold forged components and a discussion of why it is that cold forming is so often overlooked when sourcing a component producer.

Product Development Concerns Regarding Micro Component Manufacturing Processes

Metal Component Manufacturing Technology Attributes				
Manufacturing Technology				
	Cold Forming Heading	**Screw/Swiss Machining**	**Stamping**	**MIM**
Material Scrap	Typically less than 2-3%	As much as 50-70%	As much as 30+%	Typically less than 5%
Production Rate (PPM)	90-350+	Typically 4-6	100+	100+
Component Mechanical Strength	Ideal – retains native material properties	Poor – grain boundaries broken/cut	Reduction proportional to centroid distance	Acceptable except for possible lateral fatigue
Total Cost	Generally lowest for 50,000 or > EAU quantities	Generally lowest for <10,000 EAU quantities	Economical solution for high volume EAU quantities of simple shapes	Generally higher due to required secondary operations
Component Geometry	Ideal for complex variable internal and external feature depth and thickness	Allows for large variability in feature outside diameters along part length	Well suited for parts with modest internal feature variation and a flatter profile	Supports complicated assymetrical part features
Secondary Operations	Minimal – process generally produces burr-free parts off machine	Requires deburring	Generally requires deburring and possible machining	Requires vacuum heat treat and trimming
FAI Lead Time	Generally 2-13 weeks	Generally 1-2 weeks	Generally 4-13 weeks	Generally 4-13 weeks
Tooling	Modest initial investment	Low cost	High initial investment	High initial investment

Example of cold formed components 1

Glass to Metal Seal with Terminal Flattened and a Pierced Oval Hole

Use: Terminal component in high volume glass to metal seal (hermetic) electronics devices.

Material: Expansion Alloy: 52 alloy (nickel/iron alloy) per ASTM F-30 glass-to-metal seal quality.

Manufacturing Method:

Formed & pierced on a slide machine. Complete off machine.

Notable Features:

- Very good surface finish present on the sealing surfaces. No leak paths.
- Hole (oval) diameter is centered inside terminal flat area.
- Hole diameter held to +/- .002" (+/- .05mm).
- Flat end is trimmed perpendicular to lead axis.

Advantages:

- Material waste is minimal.
- Cold forming the pin eliminates the presence of spiral machining lines.
- Production speeds are high allowing for low production costs on high volume production runs. Much faster than machining/much less material cost than machining.

Example of cold formed components 2

Ceramic Surge Protector Component

Use: Mounting surface/heat sink for diode chip

Material: CDA 102 oxygen free copper/high conductivity

Manufacturing Method:

- Multi Die cold formed
- Manufactured as a complete part on proprietary manufacturer designed & built cold form tooling

Notable Features:

- Micro dimples (.010", .3mm) on minor OD
- Sharp corners on pedestal edges
- Smooth finish on .040" diameter surface (die mount surface)
- Note: precise chamfer on one end

Advantages:

- Formed from wire. No machining needed.
- Production speeds are high allowing for low production costs. Much faster than machining or turning.

Example of cold formed components 3

Ceramic Surge Protector Component

Use: Glass to metal seal body used in airbag igniters.

Manufacturing Method:

- Multi Die cold formed.
- Manufactured as a complete part on proprietary designed & built cold form tooling.

Notable Features:

- Double Diameter OD major & minor ODs.
- Center hole is a through hole with high surface finish.

Advantages:

- Formed from wire with minor (planned) scrap.
- Production speeds are high allowing for low production costs. Much faster than machining or grinding.
- The inside diameter is punched and therefore there are no spiral drill lines that would create a leak path.
- Top surface is flat with a good surface finish for wire bonding.
- Rectangular feature is inexpensively cold formed much more efficient than machining.
- Material is suitable for welding (low carbon content).

Bringing Cold Forging In From the Cold

So, if cold forging is so great, why isn't everybody using it?

In Academia, industrial engineering programs include machining design as a standard undergraduate requisite, whereas cold forging is barely mentioned. Universities offering advanced coursework in cold forging design are few and far between compared to the ubiquity of study programs offering design for injection molding, stamping, and machining.

Once out of academic settings, few commercial training programs offer much in the way of cold forming training. Because micro-component manufacturers offering cold forging are rare, so are institutions offering the necessary design training. In order to maintain a proficiency in cold forging techniques, much of the commercial training must be provided by the makers of the cold forge equipment themselves. This training, however, is usually geared toward the purchasers of the cold forge machinery, and not the product engineers.

Consequently, product development teams reach for the tools they know, and rarely do those on the team have experience with cold forging. This means that in order for cold forging companies to thrive in a marketplace of engineers unfamiliar with the process, they must offer vertically integrated service, bringing to the table knowledge of every step of making a part that meets customer specifications. New product developers can expect far more than just a component manufacturer. They can expect collaboration on all levels of development, from material selection, to design, to prototype, to production. Sussex Wire can assist you in gaining that competitive edge without compromising quality.

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