How-to

Three Ways to Achieve a Specific Metal Finish

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A part surface can require a specific metal finish for many reasons, be it cosmetic, product functionality, or customer preference. Certain metal finishes also can help the material resist damage or rusting.

Some applications require a precisely measured finish on metal parts, while others need only look visually appealing. On many jobs, the consistency of surface appearance is the most important factor in judging a metal finish. Each finish also can have a variety of coatings and treatments like clear coating, patina, and steel blackening. Which abrasive product you use for the job, the grit type and size of the abrasive grain, and operator technique all affect surface finish and can produce different results.

Measured Versus Visual Finishes

Metal is ground and polished to either a *visual finish*, which is subjective, or a *measured finish*, which is objective. Metal surfaces might appear smooth to the naked eye, but they actually contain peaks and valleys that can be precisely measured, usually with the Ra (roughness average) or RMS (root mean square) metric. Measuring these is critical if an operation needs to produce a measured finish.

Quality personnel measure the surface roughness with a profilometer, which determines Ra values by moving a diamond stylus across the surface for a specified distance and using a specified contact force. They then assign the Ra value as an average of the surface deviations. A low number represents a smoother, or less deviant, surface.

While less common than visual finishes, measured finishes might be needed in applications where two parts come into contact with one another and require a precise, smooth finish to avoid friction. Measured finishes are almost always specified in food-grade and aerospace applications that require stringent quality testing.

In applications where the material will be powder-coated or treated, the finish might not be as critical, and a visual finish or a nonmeasured finish is often acceptable. Still, if a part will be painted, it should be relatively free of deep abrasions.

Common Metal Finishes

Fabricated metal components have a wide range of finishes. Four common ones are mill, directional, nondirectional, and mirror-polish finishes.

A *mill finish* (also called a *2B finish*) is the unabraded material from a producing mill. It's how the material—be it carbon, cold-rolled, or hot-rolled steel—appears straight off the production machine. Mill finishes can be difficult to match with a hand-held tool or abrasive product, so it's important to make sure the surface isn't scratched significantly during welding or finishing. Applying any type of abrasive to a mill finish will produce scratches or swirling.

Directional finishes are common on stainless steel products, such as a refrigerator door. These finishes come in several varieties, including hairline and #4 finishes. Hairline finishes have light, "hairline" directional markings, while #4 finishes are coarser with more pronounced striations.

Nondirectional finishes, on the other hand, don't have a clear directional pattern. Fabricators create a consistent, nondirectional pattern by stepping up to a high-grit hook-and-loop or pressure-sensitive adhesive (PSA) sanding disc on an orbital sander. Fab shops apply most nondirectional finishes as the final stage before some kind of surface treatment, such as tinted clear coat, patina, steel blackening, bluing, painting, or waxing.

Different grinding tools, including wheels, discs, and brushes, serve unique purposes and create specific finishes.

Some jobs have a *mirror-polish finish* requirement. Mimicking a machine-made mirror polish by hand isn't easy. If done manually, a mirror polish is one of the most labor-intensive visual finishes, and one of the most difficult to keep consistent. To achieve a flawless mirror-polish finish, operators must follow specific grinding and polishing steps. Because the finish is so difficult to achieve, many companies buy pre-mirror-polished metal, cut it to size, weld it as needed, and then blend it by manually grinding and polishing only the areas around the weld.

Common Abrasive Discs

Ideal for pure stock removal, *flap discs*—as well as their *mini-flap-disc* cousins that can reach into tight areas—remove material quickly and create a consistent profile. To achieve smoother finishes, operators can step down to finer grain sizes, such as from a 36 to an 80 or 120 grit. That said, a flap disc alone usually can't provide a visual finish. An application that ends with a flap disc typically involves products with no specified finish or workpieces that will have surface treatment applied.

Flap discs come in various grain types, including ceramic and zirconia alumina. Ceramic flap discs often

come with a topcoat, which can be ideal for heat-sensitive applications. Heat can discolor the base material (especially stainless steel) and cause a rough finish. Both the ceramic grain and the topcoat reduce that heat.

Resin fiber discs, which can blend the base material around a weld, might also be used in place of flap discs. A skilled operator can use these discs to blend and create surface patterns. To achieve an extremely smooth finish, operators can use an orbital sander with a high-grit resin fiber abrasive in the proper sequence. To increase the sander's effectiveness, an operator can add a compound or perform wet polishing.

The finishes resin fiber discs achieve reflect the grain size chosen and, as with the flap disc, the same general rules of grain and grit size apply: The finer the grit, the smoother the finish. A finish that ends with a resin fiber disc typically has no specified finish or will have a surface treatment applied.

An excellent choice for finishing a variety of metals, *nonwoven abrasives* create a consistent, cohesive smoothness on metal surfaces. They work well for achieving cross patterns, and they can remove discoloration on stainless steel. They're available in hand pads, unitized wheels, and surface conditioning discs.

Surface conditioning discs or nonwoven abrasives come in varying grades, from very fine to medium and coarse. Starting the process, a coarse disc takes out the surface imperfections and prepares the surface for refinement. The medium disc enhances the surface left from the coarse grade and leaves a bright, satin finish. The very fine grade continues the finish enhancement, leaving a glossy, silken finish.

Wire brushes work well when metal removal is not allowed or desired. Brushes with small wire diameters apply slight scratch patterns to blend and improve visual finishing, though wire brushes typically are not recommended for painted surfaces. The finer the wire, the smaller the resulting scratches, and the better the finish.

Keep in mind that wire brushes can't remove scratches left by a flap disc; they can only refine the existing finish. Because they don't remove base material, wire brushes often work well for removing heat discoloration on stainless steel. A nylon abrasive product or nylon product can also remove heat discoloration, remove burrs, radius edges, and provide a scratch finish, which may improve surface finishes to some degree.

Applications that specify a very fine, measured finish, such as for some commercial and retail appliance workpieces, may require mechanized buffing and polishing. Manufacturers sometimes integrate mechanized grinding systems for time-consuming work on repeating products. However, most industrial applications have basic finishes achievable with the right abrasive products installed on bench wheels, right-angle grinders, and other hand tools.

*Continue reading this article in its entirety **here** to learn how to choose the best abrasive for the job.*

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