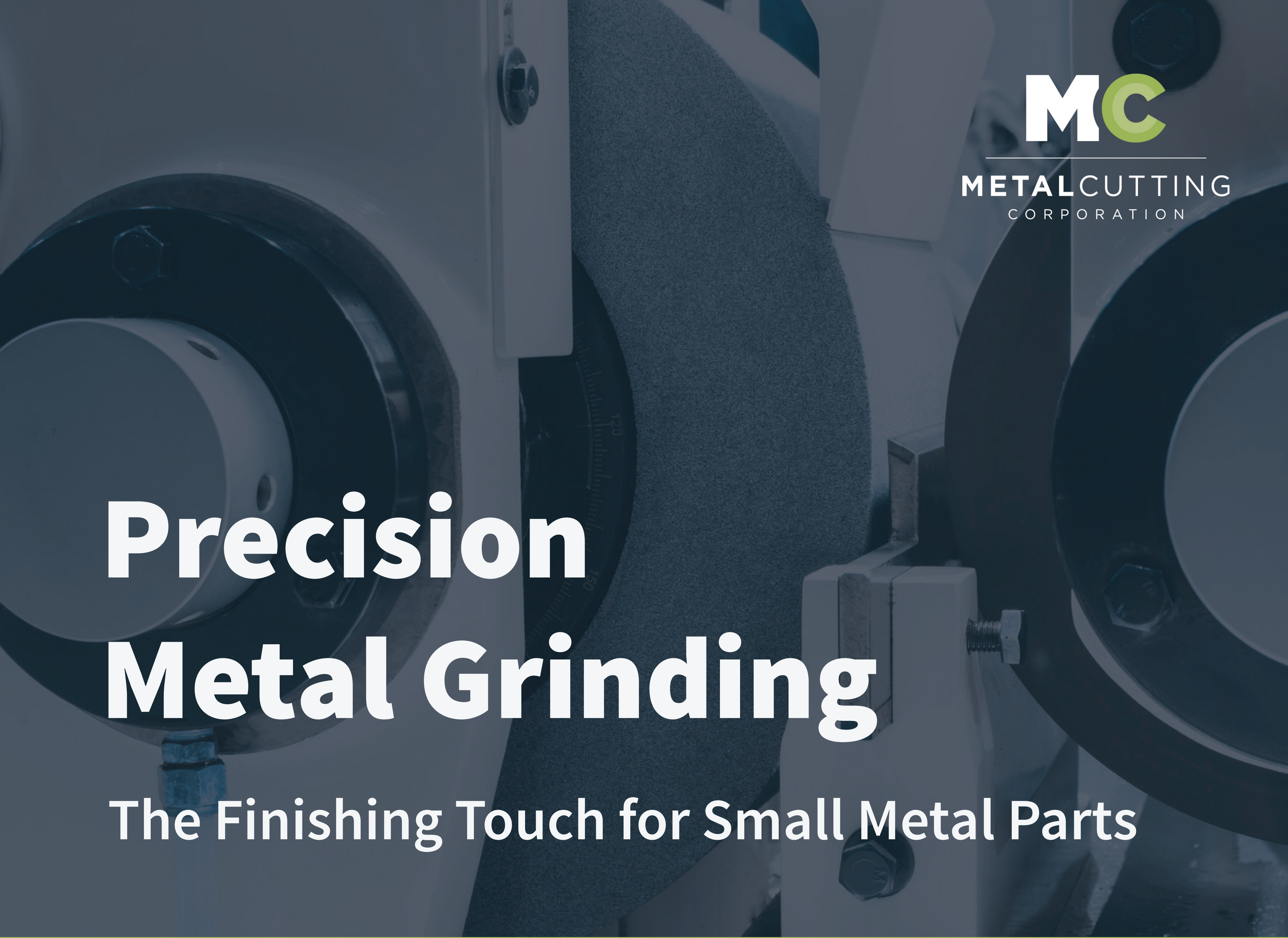


METALCUTTING
CORPORATION

Precision Metal Grinding

The Finishing Touch for Small Metal Parts

TABLE OF CONTENTS

INTRODUCTION:
What is precision metal grinding?

If you're in the business of making products using small metal parts of various shapes and sizes, you might wonder whether precision metal grinding would benefit you.

Akin to the abrasive cutting method we use for 2-axis cutoff, metal grinding uses an abrasive wheel (or wheels) to remove material from workpieces. In fact, grinding is often considered a subset of cutting, and vice versa, since each grain of abrasive on a grinding wheel acts like a microscopic, sharp cutting edge that shears a tiny chip from a part surface.

In general, precision metal grinding processes are used to remove small amounts of material in order to achieve a particular finish or tight tolerance dimensions on part surfaces.

There are different types of grinding machines, as well as many different scenarios where precision metal grinding can be used. It is the best alternative when turning or other machining methods can't be used:

- Due to the type of material
- Because of the surface finish required
- When producing small diameters
- When faced with really tight tolerances

For instance, when a part is made of tool steel, molybdenum, or tungsten, turning tools simply aren't strong enough to cut and shape those hard materials. Grinding also works better than milling on very hard materials.

Turning machine manufacturers may claim their equipment can achieve a surface finish of Ra 8 μin (0.20 μm) to Ra 16 μin (0.41 μm), depending on the tools, speeds, and feeds. However, when surface finish is critical to functionality, a ground finish is the gold standard to which other methods aspire.

Grinding is capable of making very shallow cuts — for example, to reduce a part diameter by 0.0005" (12.7 μm). In the hands of an expert, precision metal grinding can achieve sub-micron-level tolerances and surface finishes on even the tiniest tube and wire diameters.

All that being said, how do you know which of the different grinding methods might be appropriate for your specific application? And how do you make sure you get the best results?

IN THIS PAPER, WE'LL DISCUSS:

- Some of the processes commonly used for precision metal grinding
- Factors that go into choosing a grinding method
- Tips for creating a great RFQ that will help you get a more accurate quote
- Things to look for in a precision metal grinding partner
- Quality measures that can help the production process go smoothly

What are your options for grinding small metal parts?

Precision metal grinding processes remove material from a workpiece to achieve the desired surface finish and dimension. Some of the most commonly used forms of grinding are:

- Centerless grinding
- OD grinding
- Internal grinding
- Surface grinding
- Electrochemical grinding
- Double disk grinding

Depending on the method, grinding can be well suited to high-volume production for applications requiring thousands of parts. In addition, some grinding processes can be used to rapidly rough out large volumes of metal.

As with any metal fabrication method, there are advantages and disadvantages to each of the metal grinding processes depending on the proposed use and the parameters of the project.

CENTERLESS GRINDING

Centerless grinding is an abrasive process that removes material and renders a specific finish to the outside diameter of tight tolerance, small cylindrical metal parts. The process can be used to improve the surface finish of parts that were previously machined (turned).

Centerless grinding combines the actions of an abrasive grinding wheel and a smaller diameter regulating wheel. During the process, the two wheels rotate in the same direction but with the grinding wheel at a higher speed than the slower regulating wheel.

Unlike traditional OD grinding machines, in centerless grinding the workpiece is not held between centers or chucked. Instead, the workpiece is supported on its outside diameter by a workpiece rest blade.

This allows the centerless process to be used to grind very small parts on which it would otherwise be difficult or impossible because locating a true center is simply impossible. Without the need for fixturing or push or pull motors, the workpiece is moved through the machine by the grinding process itself and the “magic” of the angle between the two wheels.

DIFFERENT METHODS OF CENTERLESS GRINDING

The two most common methods of centerless grinding differ in (1) the function of the regulating wheel, (2) the way workpieces are fed through the machine, and (3) the shape of the parts that can be ground.

- In **through-feed centerless grinding**, the regulating wheel is canted away from the plane of the grinding wheel to control the liner travel of parts through the grinding machine. The angle of the wheels relative to each other exerts a lateral force that feeds a workpiece straight through the grinding wheels.

  Through-feed grinding can only be used for simple, cylindrically shaped parts without tapers or shoulders, and generally with a single diameter size. However, the angle of the regulating wheel can be adjusted to accommodate parts of different sizes. And because the method does not require a separate mechanism to feed parts through the machine, it is especially efficient.

- **In-feed centerless grinding** (or "plunge grinding") is used to accurately grind parts with more complex shapes, such as minimally invasive guide wires that can transition over a length of 2 meters from a starting diameter of 0.016" (0.4 mm) to a distal tip diameter as small as 0.002" (0.05 mm). The in-feed method has evolved into machines with and even without regulating wheels, both styles using CNC technology to control the rotational speed and feed rate of parts as they move through the machine.

  With in-feed grinders, parts are either loaded manually or with automatic loaders. The regulating wheel moves in and out to produce different diameters and transitions — the tapers and sizes that distinguish in-feed ground parts. The combination of the complex part shape and the wheels, which must be dressed to match the desired part shape, keeps the parts moving through the machine.

The machines are designed for their specific purpose and not used for anything besides centerless grinding. Interestingly, an in-feed grinding machine can be fixed into place for a specific diameter gap to be used for through-feed grinding, but not vice versa.

Although the centerless grinding process has been around for nearly a century, modern machines include CNC, laser gaging, and other innovative features designed to enhance precision and the level of automation.

To learn more, see our blog on centerless grinding.

OD GRINDING

Outside diameter (OD) grinding is a type of cylindrical grinding that uses a single wheel to shape the outside surface of an object between the centers. While the process can be used on a variety of part shapes — such as cylinders, ellipses, and cams — the workpiece must have a central axis of sufficient diameter that allows the object to be rotated.

During the OD grinding process, both the workpiece and the grinding wheel are constantly rotating in the same direction around that central axis. Either the workpiece or the wheel is traversed with respect to the other.

As the wheel is fed towards and away from the workpiece, the two surfaces — wheel and workpiece — are, in effect, moving in opposite directions when contact is made, allowing for smooth operation.

The surfaces produced by OD grinding can be straight, tapered, or contoured. The characteristics of the finished surface will vary depending on the hardness of the material being ground, the grain of the wheel, feed rate, and other factors.

In addition, by the very nature of the way OD grinding is accomplished, the process is limited to parts on which the central axis can be found. That means OD grinding is generally not used on parts with a diameter of 0.250” (6.35 mm) or smaller.

However, with proper wheel dressing, conditioning, and lubrication, OD grinding is great for creating or correcting round features on parts with a center. And thanks to motion control advances such as CNC, today’s OD grinders can produce small, precise parts in high volume.

To learn more, see our blog on OD grinding.

INTERNAL GRINDING

Internal grinding is an abrasive process that removes material on the inside diameter (ID) of tubes or the ID of part features such as bores or holes. Along with honing, ID grinding is used to create smooth surface finishes and tight tolerance on IDs.

Both ID grinding and honing require the object to be held and rotated in place, limiting how small the part diameter can be. In addition, the grinding wheel or honing stone must be smaller than the inside diameter of the object to be ground.

For parts that require ID finishing — usually at the end of the manufacturing process — the choice between ID grinding or honing often depends on how much material must be removed and what Ra finish is required.

ID grinding is generally used to quickly remove material from the ID of a cylindrical or conical part, to achieve a tight tolerance dimension to thousandths of an inch. It can also be used to remove porous surface layers and introduce certain shapes into the cavities of cast parts.

Honing relies on harder tooling, and while it removes less material, it is capable of removing material to ten thousandths of an inch. So, honing is used to polish or achieve a very precise surface finish and shape on a part ID. For instance, It can be used to improve the shape and surface texture of the ID of complex tubing.

(Some people confuse honing with lapping — another abrasive method used as a finishing process to create a smooth surface and precision dimensions on metal parts. But while both have similar uses, they are very different in where and how they get results. **Read more about honing vs. lapping here.**)

The choice of abrasive used for either an ID grinding wheel or a honing stone depends on the characteristics of the workpiece material. In addition, the grit size determines what Ra can be achieved.

But in general, grinding produces a rougher finish, while honing can produce a finish as smooth as Ra 1 µin (0.03 µm). However, honing is a more expensive process, making it impractical for some applications.

To learn more, see our blog on internal grinding.

SURFACE GRINDING

Surface grinding is a machining method that is widely used for producing a smooth finish on flat surfaces. The process involves a rotating wheel covered in rough abrasive particles that “cut” tiny chips from a workpiece surface.

In addition to the wheel, a surface grinding machine consists of a chuck, which generally uses magnets to hold the workpiece in place, and a reciprocating table. The grinder’s reciprocating action ensures that the process removes material in tiny, precise, repeating increments.

Surface grinding is often used to achieve parallelism and squareness in cubic parts or to make the two ends of a metal rod perpendicular to the rod’s outside diameter. As an alternative when turning or milling is simply not precise enough, surface grinding can achieve micron-level tolerances and surface finishes down to Ra 8 μin (0.20 μm).

As with other grinding methods, the finish achieved with surface grinding depends on a wide range of factors, such as the material characteristics, feed rate, wheel speed, wheel size, and abrasive type.

The machines can also be fixtured to make different shapes, forms, corners, chamfers, and radiuses. Attachments can even mimic the principles of centerless grinding and provide unique fully spherical ground features.

In addition, the surface grinding method known as creep-feed grinding allows a large amount of material to be removed in a single, slow pass of the wheel rather than a series of fast, tiny, lateral cuts.

Surface grinding works well with various types of steel and cast iron — materials that can be held by the magnetic chuck and do not clog the grinding wheel. Metals such as stainless steel, aluminum, and brass can also be surface ground, but they require special techniques to prevent the materials from clogging the wheel.

However, the integration of CNC and other programmable features allow for automatic operation, enabling surface grinding to be used for high volume production.

To learn more, see our blog on surface grinding.

ELECTROCHEMICAL GRINDING

The electrochemical grinding process is a highly specialized and complex version of surface grinding. The process has limited applications, many of them in the medical device industry.

Electrochemical grinding combines electrical and chemical reactivity with the abrasive action of a grinding wheel. In the simplest terms, the process creates an electrically charged environment where a metal part is eroded to achieve a specific surface finish.

When electrochemical grinding is performed correctly, most of the material removal is due to erosion rather than abrasive action, producing little heat or stress that could damage delicate parts. Ideally, abrasive grinding occurs only to remove the oxide film that forms on the surface of the workpiece during the process.

Electrochemical grinding is capable of achieving a surface of Ra 16 µin (0.41 µm). However, unlike with traditional abrasive grinding, the finish is matte rather than highly polished.

While electrochemical grinding works with different metals, the material that is being ground must be conductive and electrochemically reactive. The grinding wheel must also be conductive. For optimal results, special chemicals should be used for each type of metal.

Since each metal has a unique chemistry and its own conductivity characteristics, the success of the process depends on getting all the variables exactly right, to create the perfect electrochemical environment.

Fixturing or secondary steps may also be required if the goal is to achieve complex end configurations, rounded edges, corners, or acute cutting edges. Electrochemical grinding can be automated, which offers part-handling benefits — for loading, orientation, and unloading — but adds to the cost and complexity of the process.

Unique in the machining business, the tooling itself must be protected from the electrochemical erosion process. On the plus side, although electrochemical grinding can be used to shape very hard metals, the process minimizes tool wear.

This enables the expensive conductive grinding wheel to last much longer than the wheels used in conventional abrasive grinding methods.

To learn more, see our blog on electrochemical grinding.

DOUBLE DISK GRINDING

Double disk grinding is used to achieve highly accurate dimensions on metal parts that require tight tolerances, parallelism, flatness, and thickness control. Using two abrasive wheels that are opposite each other, the process grinds two sides of a material at the same time.

The wheels are mounted on a pair of spindles in either a vertical or horizontal configuration. Parts are automatically fed from a vibratory bowl, and the angle of the wheel carries them through the arc of the wheels (usually 120° degrees) without any need to motorize transport.

With the ability to remove equal amounts of material on two sides of a part at once, the double disk process can grind more quickly than a method such as surface grinding. So for the right applications, double disk grinding can increase efficiency and reduce costs.

Ultimately the material removal rate depends on the wheel choice and variables such as wheel RPMs, feed, and grind speed, as well as the skills of the machinist and how much material needs to be removed. In general, however, double disk grinding is reliable for mass production, providing consistent part-to-part parallelism and flatness.

Double disk grinding can be used with a wide range of materials, including stainless steel, tool steels, sintered metals, and high-strength alloys. The resulting surface finish is often better than the finish produced by many other grinding techniques.

For example, double disk grinding can achieve surface finishes of up 16 Ra μin (0.41 μm) on aluminum and up to Ra 8 μin (0.20 μm) on ferrous alloys.

Flat lapping is another abrasive process often considered an alternative to double disk grinding for tight control of surface finish, flatness, thickness, and parallelism. (**You can read more about flat lapping here.**) While it is true that either method can be used on the same parts to achieve an accurate surface finish, flat lapping can provide surface finishes as smooth as Ra 4 μin (0.10 μm).

However, there are important differences in automation, process speed, and labor that make double disk grinding more cost-effective for certain applications. For example, lapping requires hand loading and unloading of parts, which drives up the cost.

To learn more, see our blog on double disk grinding.

As you can see, subtle differences between the different processes used for precision metal grinding mean that no one method is suited to all goals, materials, tolerances, or production needs. So, how do you choose a grinding process for *your* application?

In the next section, we'll look at some of the factors that go into deciding between different metal grinding options.

How do you choose a precision grinding process?

With the different metal grinding options varying in benefits, drawbacks, and appropriate applications, choosing among them is not always easy. But the decision matters a great deal, since picking a less-than-ideal process can result in production delays, material waste, or other quality issues that will cost you time and money.

The choice of grinding process ultimately comes down to the requirements of the specific job you want to do. The challenge is to balance any negatives with how well suited a grinding method is to your application.

You can get closer to the right solution for your needs by considering some of the key parameters we've outlined below.

WHAT KIND OF PART DO YOU NEED TO GRIND?

It seems obvious, but before you choose a precision metal grinding process, you need to consider what type of part you will be working with, such as rods, tubes, wires, or extrusions. After all, not every grinding process will excel at all part types.

For instance, if you goal is to create a smooth surface finish on the inside diameter of a tube, it makes sense that you'd choose a method such as ID grinding or honing.

WHAT TYPE OF METAL DO YOU WANT TO GRIND?

The physical properties of metals have a huge impact on the how effective a precision metal grinding process will be. An obvious example is if you wanted to use electrochemical grinding, you would first need to know how well the metal conducts electricity.

Other properties that may have an effect on how well a grinding process will perform include material hardness, heat conductivity, ductility, malleability, strength, and melting point.

ARE THE PART DIMENSIONS COMPATIBLE WITH THE GRINDING PROCESS?

Although precision grinding produces very tight tolerance surface finishes, the capability is not the same across all the different grinding processes.

For example, because there is no axial thrust on parts during the centerless grinding process, it can be used to grind long pieces of brittle material without distorting them or causing them to shatter. However, for these parts, OD grinding would be impossible.

In addition, a particular process might excel at one aspect of your part spec but fall short in another aspect. For instance, while OD grinding is great for correcting surface defects and returning a part to perfect circularity, it cannot be used on very small parts where it is impossible to find the true center.

WHAT PART TOLERANCE DO YOU NEED, VS. THE TOLERANCE YOU WANT?

Determining what tolerance you really need to achieve and the amount of variation that is acceptable is critical to choosing a grinding process. For example, while all of the processes we talked about above are good for tight tolerances, some are more effective in certain tolerance ranges.

There are also certain principles that apply. For instance, the larger a part becomes, the harder it becomes to hold overall tight tolerances. Plus or minus a micron is completely different on a part that is 0.10 mm in diameter than on a part that is 10.0 mm in diameter.

In addition to their potential impact on part functionality, tolerances are critically important in terms of costs. As we always like to point out, extending a tolerance out by even one decimal point can increase the cost by a factor of two or three.

Unless a tight tolerance is within the nominal capabilities of the particular metal grinding process you want to use, asking for that tight a tolerance will increase the cost of production. (You can read more about tolerances in the next section, on how to get a more accurate quote.)

WHAT ARE YOUR PRODUCTION/CAPACITY NEEDS?

When choosing a precision metal grinding process, also consider the relationship between volume, speed, and cost. In short, that means you need to determine whether a particular metal grinding process is cost-effective for the volume you need and how quickly you need it.

By realistically prioritizing and clearly stating what you need — how many parts, in what timeframe, and at what cost — you can determine whether a grinding method will satisfy your production requirements.

HOW DO THE PARAMETERS AND GRINDING METHODS COME TOGETHER?

The efficiency of any precision metal grinding process depends on the how well the process matches up with the work you need to accomplish.

The table below provides a quick overview of some advantages and disadvantages for each of the grinding methods we've discussed, to help you compare them.

TABLE 1: COMPARISON OF PRECISION METAL GRINDING METHODS

Grinding Method	Advantages	Disadvantages
Centerless Grinding	• Tight tolerance OD finishing • High volume and fast speed • Very small parts with no centers or chucking needed • Complex shapes (in-feed)	• Coolant required to remove heat • Very specialized applications
OD Grinding	• Tight tolerance OD finishes • Variety of part shapes • Excels at creating or correcting roundness	• Requires central axis • No part diameters 0.250” (6.35 mm) or smaller
Internal Grinding	• Smooth surface finishes • Tight tolerance IDs • Material removal to thousandths of an inch	• Object must be held and rotated • No very small diameters • Not suitable for automated part loading
Surface Grinding	• Smooth surfaces on flat surface • Parallelism, squareness, and perpendicularity • Finishes down to Ra 8 µin (0.20 µm)	• Limited applications • Slow material removal rate
Electrochemical Grinding	• Little heat or stress on parts • Capable of 16 Ra µin (0.41 µm) • Minimal wheel/tool wear	• Conductive materials only • Complex, erosive process • Unique “recipe” for each metal
Double Disk Grinding	• Tight control of tolerances, parallelism, flatness, and thickness • Two-sided grinding for speed and cost-efficiency • Automatic part loading	• Ground finish inferior to a free abrasive lapping slurry process

Once you’ve chosen the metal grinding process you think best matches your job requirements, it’s time to put those requirements into an RFQ. So, up next are tips on how to create specifications that will help you get a more accurate quote.

What’s the secret to getting a more accurate quote?

Part sourcing can be a somewhat complex process, especially when you’re dealing with small parts that have very precise requirements. But the good news is it doesn’t have to be a chore.

Putting together a quote request that accurately reflects what you want and need — in areas including tolerances, dimensional accuracy, and materials — will go a long way in helping you get an accurate quote.

Since the quote you get will also form the basis of your vendor partnership, as much as possible you want to make sure you’re starting out with a realistic statement of what you want, need, and expect. And of course, specifying your requirements as thoroughly as possible will ultimately help you get the quality you want in the final product.

Below are some quick tips on preparing an RFQ that will help to ensure the best results — not just for precision metal grinding, but for any metal cutting, machining, finishing, or fabrication project.

DON’T ASSUME YOU NEED THE TIGHTEST TOLERANCE POSSIBLE.

Depending on how a part will be used, it might not be necessary to hold the very tightest tolerance possible on any given grinding machine — in effect, over-engineering the part and driving up its cost unnecessarily. Instead, while it may be tempting to always go for the tightest tolerance, be realistic about the tolerances you specify for metal grinding and other processes.

DISTINGUISH BETWEEN CRITICAL AND NON-CRITICAL TOLERANCES.

It’s not uncommon to have one part with different attributes that require tolerances — such as both a diameter and a surface finish. However, it is important to focus on what will have the biggest impact on part functionality.

Fortunately, you can generally distinguish between critical and non-critical tolerances by looking at where a part will go, if and how it interacts with other parts, and what the part needs to do in the end application.

RESERVE THE TIGHTEST TOLERANCE FOR YOUR MOST CRITICAL DIMENSION.

Chances are good that the most critical dimension is the one that ultimately determines how well a part will function. This critical dimension and its tolerance are what will determine which grinding process will be used, driving the cost of the part.

Sometime a single part will have conflicting tolerances — an easily met, loose tolerance on one dimension and a tight tolerance on another dimension — that require a compromise. That is, you can adjust the looser tolerance slightly (up or down) to help achieve your most critical dimension.

INCLUDE AN ENGINEERING DRAWING WITH THE DIMENSIONS AND TOLERANCES SPECIFIED.

In any request for a precision metal grinding quote, it is preferable to include a detailed engineering drawing. Whether you are working with a new vendor, creating a new part, or updating an existing part, providing callouts for GD&T tolerances and all the part dimensions will — literally — give your vendor a clear picture of what you need.

DESCRIBE THE CHARACTERISTICS OF THE PART IN DETAIL.

For instance, if some burr is allowed, provide a measurement for the maximum burr that is acceptable. If you have a profiled part with diameter steps, specify the minimum and maximum inside corner breaks that are allowed.

And if some surface defects are permitted, quantitatively specify the depth, width, and length of any allowable feature. This will remove any subjective judgment about an objective feature.

SPECIFY WHAT CALIBRATED INSTRUMENT SHOULD BE USED TO MEASURE YOUR PARTS.

Using a calibrated measuring device helps to ensure that the device is accurate and reliable, and its measurements are traceable to accepted standards. So, make sure you and your precision metal grinding vendor are using the same type of measuring devices AND the devices are correctly cross-calibrated.

DESCRIBE HOW THE PART WILL BE USED.

When a vendor fully understands the end application for your metal part, they will be better able to make suggestions about which metal grinding process to use or what metal might be required — for diverse applications from a medical-grade stainless steel for a part will be used in a medical device to a press fit pin for a hinge in a durable goods appliance.

IDENTIFY YOUR RAW MATERIAL AND ITS SOURCE.

If your metal grinding vendor has to provide the raw material for your parts, that increases their costs and, in turn, your quoted price. However, if you can provide the raw material, that puts you in control of the sourcing and how much you want to spend.

Either way, be sure to include the source, size, grade, and quantity of the material you will need.

SPECIFY THE PART QUANTITY YOU WILL NEED.

Part quantity has an effect on pricing, delivery time, minimum charges, and other aspects of building a quote. So, including a likely quantity — and frequency — in your RFQ will help your vendor provide a realistic quote.

For example, is it a one-time job or ongoing? How many pieces will you need to cut and how often — hourly, daily, weekly, or monthly? Will they be long production runs, short runs, or individual cuts? Will your quantity start small and increase in the future?

INCLUDE YOUR IDEAL TIMELINE AND TARGET PRICING.

Naturally, everyone wants their parts as quickly and affordably as possible. However, when "as soon as possible" turns into a rush order, that means added costs.

Providing a realistic deadline can help your vendor come up with a proposal that meets your production needs and your budget. Likewise, providing a target price (or a ballpark figure) will help your vendor recommend a process and timeframe that are practical for your needs.

By putting just a little extra time and effort into assembling a thorough and accurate RFQ for precision metal grinding, you'll help your vendor provide an accurate proposal and quote — and that will ultimately help you pick a partner and get the best metal parts for your application.

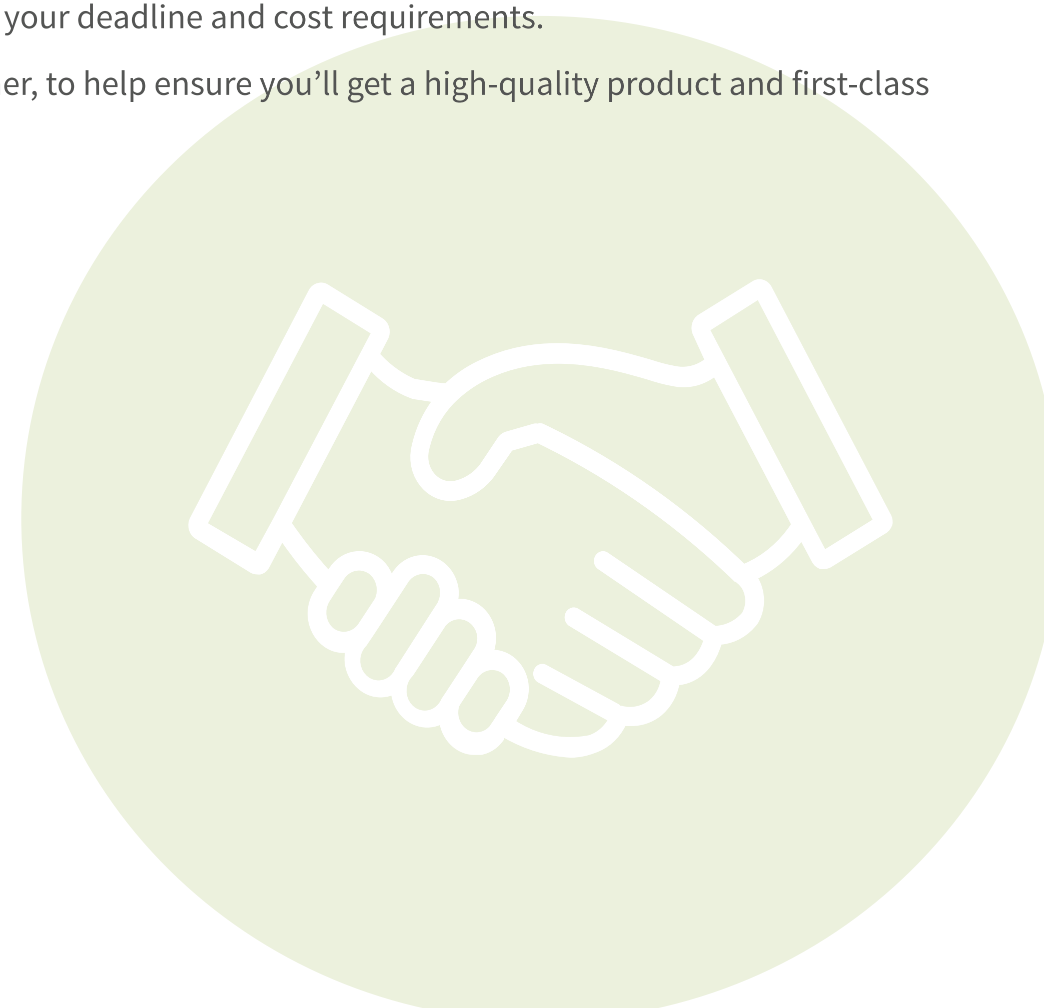
Learn more! Check out our complete guide to RFQ success.

But, what happens if you have multiple proposals with comparable pricing? What makes one vendor a better choice than others? In the next section, we'll talk about some other things to look for in a partner for your metal grinding project.

What should you look for in a precision metal grinding partner?

It's not enough to be quoted a great price by a vendor for precision metal grinding or other projects. You want to know that your partner can deliver the very best product AND meet your deadline and cost requirements.

Below are some things to look for when choosing a partner, to help ensure you'll get a high-quality product and first-class customer service.



ASK IF THE METAL GRINDING VENDOR IS ISO 9000 CERTIFIED.

ISO 9000 certification establishes formal standards for quality management in areas that are important to manufacturing, including customer focus, leadership, engagement, process approach, improvement, decision-making, and relationship management.

When a precision metal grinding vendor is ISO 9000 certified, it demonstrates that the company has invested in a quality management system (QMS) and in having those QMS practices verified by an independent, accredited auditor.

ASK ABOUT THEIR METAL GRINDING EXPERTISE.

Different vendors are more experienced in grinding certain materials, such as non-ferrous metals like tungsten and molybdenum, stainless steel, or specialty metals. So, look for a precision metal grinding partner that has expertise in the material *you* want to use.

Ask a prospective partner about their track record in grinding capabilities that are pertinent to your metal parts and application. For instance, for grinding parts with a diameter of 0.250” (6.35 mm) or smaller, ask about their ability to deliver tight tolerances using centerless grinding methods.

ASK ABOUT THEIR METAL GRINDING EQUIPMENT.

Whenever possible, it’s great to work with a precision metal grinding company that offers a choice of grinding options, equipment, and tools available in house. This can give you greater flexibility in the type of metal you can use, and can save you startup time and cost.

Also ask potential metal grinding partners if their equipment has advanced features that enhance precision and automation. For example, CNC programmable operation provides flexibility for production setup and faster changeover. Features such as computerized speeds and feeds can help to maintain accuracy and hold tight tolerances.

ASK ABOUT THEIR CAPACITY.

Verify that a potential partner has the capacity to handle your order volume and deliver the number of parts you need, and to do it on time and on budget. Also find out how much lead time the vendor typically needs, to get a sense of how quickly a project can be set up.

Asking these and other questions will not only help you choose the most qualified precision metal grinding partner for your needs — it will also show you pretty quickly how customer-focused the vendor is. The right partner will go the extra mile to deliver quality metal parts AND responsive, personalized service.

After you've chosen a metal grinding process, gotten a quote, and picked a partner, there is one more important step we recommend. Next, we'll address some of the quality control measures you can put in place before production begins.

What quality control measures should you put in place?

As with any other precision method used in high-volume part production, proper setup before manufacturing begins is vital to the success of whichever metal grinding process you choose.

Of course, any metal grinding partner that is ISO 9000 certified should already have a Quality Control plan in place and follow strict QMS practices. But you, too, can do some work up front to help optimize the production process for your given application.

DISCUSS AND AGREE ON WHAT INSPECTION METHOD TO USE.

To ensure that you get a quality end result, it's important to talk with your precision metal grinding vendor and agree on how you will determine whether the finished parts meet your specifications. In fact, the inspection method you want to use should be included in both your RFQ and your part specifications.

Since small metal parts are often produced in quantities of thousands or millions, it is common in metal grinding operations to use sampling plans as the method of inspection. Here at Metal Cutting Corporation, most projects begin with establishing a sampling plan that details how we will inspect a customer's metal parts.

The sampling plan includes an Acceptable Quality Level (AQL) and Index Value, which determine how many randomly selected parts in each lot will be inspected. We generally recommend AQL 1.0 c=0, which is a zero acceptance sampling plan — meaning if one defect is found in the sample, the entire lot is rejected or subject to 100% inspection.

In our experience, an AQL 1.0 c=0 sampling plan allows us to deliver acceptable quality levels while inspecting fewer parts and reducing inspection costs.

SPECIFY THE INSPECTION TOOLS YOU'LL USE.

Just as you and your precision metal grinding vendor need to agree on an inspection method, it is also important to agree on what will be measured and how.

This is especially true with very small metal parts that would be impossible or impractical to measure for an actual value. Such tiny parts are usually inspected using a pass-fail tool such as pin gages.

However, some companies — such as Metal Cutting Corporation — also have a wide range of tools that allow us to get closer to laboratory-level accuracy. This includes microscopy, laser micrometer, video edge detection (VED), linear variable differential transformer (LVDT), and interferometry equipment.

Discussing in advance what resources you and your precision grinding partner will use to inspect shipped and received parts will go a long way in reducing problems after the job is completed.

INCLUDE DEVICE CALIBRATION.

In addition to your inspection methods and tools, your RFQ and specs should include any calibrated measuring devices that should be used. For example, be sure to specify if you and your vendor will both use XXX, XX, X, Z, or ZZ gages, and when you will use the plus or minus versions.

Different classes of small pin gages have different tolerances attached, based on the tolerance allowed in the manufacture of each pin. The smaller the part, the more the tolerance of a pin gage matters.

So, for inspecting a critical dimension such as the ID of a small diameter, tight tolerance tube, you might want to specify a tighter tolerance pin gage. For instance, a Class XXX pin gage will be straighter and more uniform throughout its length, providing greater accuracy for inspecting the tube ID.

BE SURE YOU AND YOUR VENDOR ARE CALIBRATING TO THE SAME STANDARDS.

Across the industry, customers, suppliers, and manufacturers all calibrate the measurement devices they use. Typically, the devices are calibrated to NIST-traceable standards to ensure consistency, accuracy, and reliability.

Here at Metal Cutting, we regularly calibrate the pin gages and other tools we use for inspecting and measuring the parts we produce. In addition, the devices we use to calibrate our tools are themselves regularly sent out to be calibrated. In this way, we ensure that our inspection tools are traceable to NIST standards.

Sharing NIST-traceable calibration data — for both the actual devices being used to inspect parts and the devices used for in-house calibration — is an important step that should not be missed.

Seemingly small but sometimes overlooked details can mean the difference between smooth cooperation and complicated problem solving.

Harmonizing with your precision metal grinding partner about exactly how your parts should be measured and inspected — including the device, calibration, and procedure that will be used — will help to ensure that the process goes smoothly and you will get a quality end product.

Conclusion

There are many different variables that go into choosing both a precision metal grinding process and a vendor to perform it. To get the best results for your specific metal grinding application, our best advice is to always:

- Consider all of your project's distinct variables and unique challenges
- Include everything you can think of in your RFQ and specs — there is no such thing as too many details!
- Ask your potential partner all the questions you can think of, so you'll get a clear picture of their capabilities — and their responsiveness
- Choose a precision metal grinding company that demonstrates the flexibility and willingness to work with you to find the best solution for your needs

We hope the information presented here provides the basics you need to know and will help as you explore the different options for precision metal grinding.