Getting the Most from Your Diamond Drilling Operation

The diamond drill itself is only a small factor in your drilling operation. **Successful diamond drilling is both an art and science** that can be mastered with proper understanding of how to use:

- **Drilling speed and pressure**
- **Proper coolants**
- **Drilling accessories**
- **Selecting the right diamond drill for your material**

http://www.ukam.com/diamond_core_drills.html

While this understanding is best gained through experience, even new diamond drill users can quickly become proficient by learning and applying some basic principles of diamond drilling.

Selecting these parameters, often involves a trial and error process. Many witch can be avoided through experience and understanding of how to use these parameter for your specific application. **What works for one application, may not work for another**. While there is no real substitute for experience, even new diamond drill users can quickly become proficient by learning and applying some basic principles of diamond drilling.

The following recommendations have come from years of experience in research, development and manufacturing of precision diamond products, as well as years of personal experience and observation. Following these drilling suggestions will help you drill faster and easier, obtain a smoother surface finish, minimize damage to your material and extend the life of your diamond drill.

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UKAM Industrial Superhard Tools has over 50 years of experience in Manufacturing, Research & Development of Diamond Drills **.001" to 48"** Diameter for just about any material /application. You can count on us to help you **improve you drilling operation** to its ultimate efficiency.

SMART CUT™

FREE Advice/Consulation >>>

25345 Avenue Stanford Unit 211, Valencia, CA 91355 – tel (661) 257-2288 – fax (661) 257-3833

Before Drilling

Before beginning your drilling operation, visually examine the drill for cracks or other damage, as well as for run out. Run out will cause excess vibration when your are drilling and effect the circumference (roundness) of your hole. Instead of your hole being perfectly round, it will become ellipse and uneven. **Drill run out will also affect tolerances you are able to achieve**. To check for run out, use an indicator specifically designed for this purpose. Bring the indicator close to drill, until its spring just touches the surface of the drill. The dial of the indicator should indicate 0. Turn on your drilling machine, holding the indicator firmly in place. The dial of your indicator should remain at 0 while your drill is running (rotating). This means you have no drill run out. If your indicator is greater than zero, your drill is running out. Turn off your drilling machine, and remount the drill.

A black marker, is an alternative if you have don't have an indicator available. Take a piece of paper or any thin piece of material, measuring its thickness using a caliper or micrometer. Place the material firmly against the drill. Holding the marker firmly in place, remove material between drill and marker. Turn on your drilling machine and observe drill rotation. If the marker touches surface of the drill, there is too much drill run out. Turn off drilling machine, and try again.

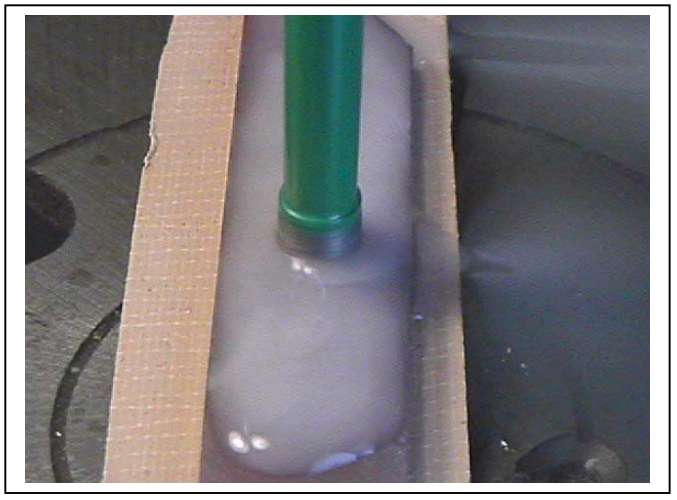
Another effective way of checking drill run out, is rotate the drill head assembly (including the water swivel adapter, if your drill has this feature) by hand. The run out of the drill diamond section (the cutting/drilling edge) will be indicated by the stem. Wobble the head of water swivel adapter using your hand. If too much vibration exists, your drill will run-out. A strong correlation exists between the run out on the water swivel adapter and on the diamond drill—the larger the run out on the water swivel adapter, the larger the run out will be on the drill. If the run out is not properly indicated, the drilling operation will not be accurate.

You should also ensure that your drilling accessories are properly held in the chuck. If the drill or drilling device is not running true, loosen the chuck of your drilling machine, turn it 90 degrees and run your drill again. If this does not work, examine condition of your equipment. Mount the drill on another drilling machine. Make sure your drilling equipment is in proper condition to accomplish your objectives. **No matter how well the diamond drill is made, it will not give you close tolerances if the shaft, or chuck of your drilling equipment is misaligned or vibrates.**

Always wear the proper safety equipment, including safety footwear, snug fitting clothing, safety goggles, hearing and head protection, and proper respiratory equipment, and do not use your drill if you suspect it is damaged. Damaged, incorrectly mounted or misused drills can be very dangerous.

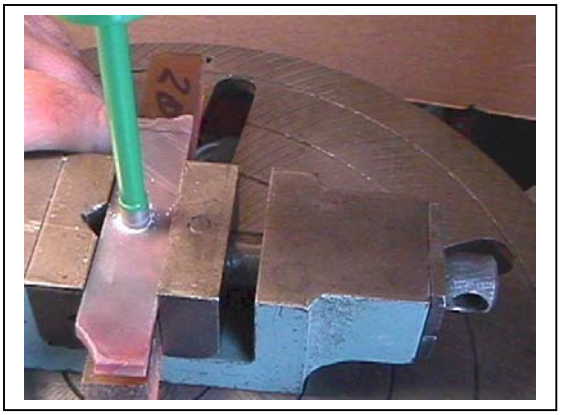
Starting a Hole

Once you have made sure that your drill is in good condition, you are ready to start your drilling operation. Clearly mark the insertion point on the material to be drilled and line the drill up to this point. Drill by quickly pressing and lifting the drill head. Moving the drill up and down frequently during the drilling operation will allow the coolant to cool the drill and flush out the material debris formed while drilling. The color of the water in the drilling zone should be milky white



Holding the material in place

Be careful not to use excessive pressure while drilling. If material debris becomes stuck inside the drill, flush it out with coolant before continuing the drilling operation.



It is also extremely important that the material or part you are drilling be **held firmly in place** with a clamp throughout the drilling operation. Any material movement can cause the diamond section of the drill to break, possibly resulting in material damage or operator injury. For drilling thinner materials and substrates consider using heavy duty double sided tape to firmly hold your material in place.

Drilling Speed and Pressure

To maximize the life of your drill and minimize material damage, it is important to run your drills at the proper drill speed and pressure. Drilling speeds vary with diameter of diamond drill, diamond mesh size, coolant being used, drill wall thickness, diamond bond type and hardness, as well as material hardness. **Micro Diamond Drills from .001"** required drilling speeds as high as **150,000+** RPM. Whereas very large diamond drills **48"** diameter require drilling speeds as low as **3 RPM's**.

Soft, abrasive materials can typically handle higher drilling speeds, while hard, dense materials require much slower speeds. Since diamond drills are primarily used in hard material applications, they are typically used at very slow speeds. **Make sure your drilling equipment can run at recommended speeds set for your diamond drills**. Faster drilling might appear to increase your production efficiency, but the tradeoff is a significant increase in friction and heat, which considerably reduces the drill life and increases the risk of heat fractures and breakage in the material being drilled.

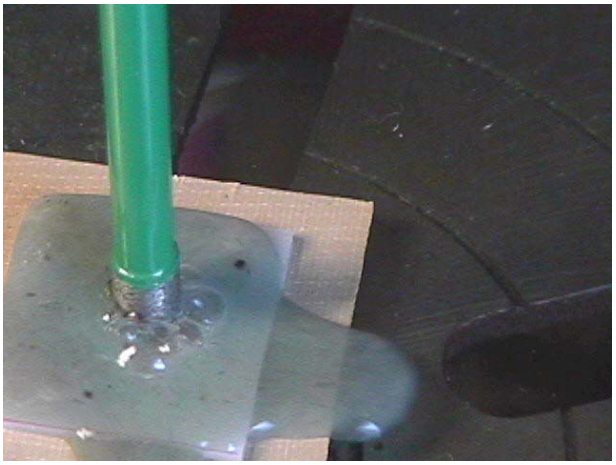
When you are drilling completely through a piece of material and the hole is near completion, reduce the drill pressure considerably to minimize chipping of the material. Never force a diamond drill. Apply even pressure until the drill and material just touch. Since the drill and material surface are not perfectly even (symmetric) to each other, this lets the drill surface become sharper and adjust to the surface of material.

If a diamond core drill develops dark "burn" marks at the diamond section, the drill speed is probably too high or the amount of pressure is too great. Reduce the drilling speed or pressure accordingly.

Coolant

The most frequent cause of diamond drill damage is drilling without enough coolant. **Never run a diamond drill dry**—coolant should always be used to cool and lubricate the drill and to flush out abrasive particles formed while drilling. Water is the most frequently used coolant because it typically provides excellent performance at a minimal cost. Water is a true organic coolant, witch does not leave the material being machined oily, greasy, or contaminated.

Other types of coolant include: synthetic water soluble coolants, mineral oils, other oils, and air. If you are planning to use water as a coolant, check with the drill manufacturer to find out what water pressure is required and if any additives are recommended. (Note that using additives will require a circulating system to ensure that the right ratio is maintained between your additive and coolant.)



The coolant must also be applied in the right place to ensure that it properly cools the drill and the material being drilled. The coolant should be directed so that the full flow is at the point of contact between the drill and the material, facing the same direction as the rotation of the drill.

When drilling on a vertical surface (not recommended for hard materials), use a squirt bottle or small cup of water to continuously pour water onto the drilling zone. Make sure enough coolant is reaching the drill. Alternatively, you can submerge the material into a shallow tub of coolant so that the coolant just barely covers the material surface. ***If coolants cannot be used,*** consider using air to cool your diamond drills. If air cannot be used, a resin bond or electroplated (nickel bonded) diamond drill may be a solution.

Using Proper Drilling Accessories

Most Diamond Drills are used on a horizontal surface and with coolant through center of drill. If your current drilling equipment does not provide coolant center feed capabilities, consider using a water swivel adapter. These devices provide a constant, controllable flow of coolant through the center of the drill and are designed to efficiently and effectively cool both the drill and the material in the drilling zone**. Water swivel adapters, also known as drill head assemblies can help increase life of your diamond drill by as much as 40% to 75% on average**.

Running coolant through center of your drills is the best method for drilling very hard materials. Doing so will help you improve material surface finish and prevent many micro cracks that are associated with material overheating while drilling. UKAM Industrial Superhard Tools manufactures water swivel adapters to fit just about any drilling equipment. When considering using a water swivel adapter, make sure it is designed to be used with RPM's you are planning to run your drills. Water swivel adapters that are made
from stainless steel, ball bearings, and with adjustable water flow, are preferable over water swivel adapters made from brass and no bearings.

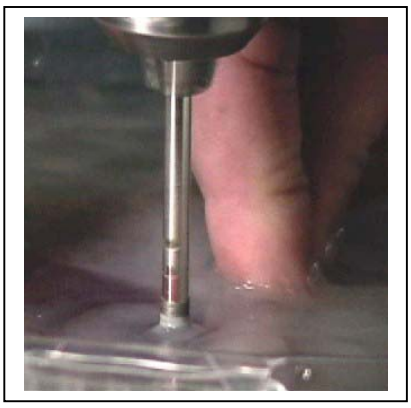
Water Swivel Adapters are generally used with sintered (metal bond) diamond drills or hybrid™ bond diamond drills that are mounted on a collet with female thread.

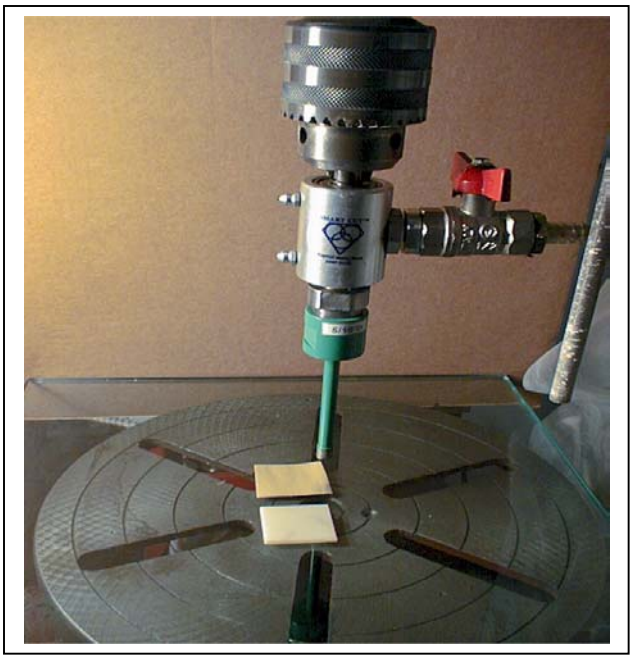
http://www.ukam.com/water_swivel_adopters.html

Water swivel adapters are designed to fit all standard diamond drills with 5/8-11” thread, other thread sizes are available. Diamond solid drills and most Electroplated (nickel bond) Diamond Drills are usually made with a straight shank and not designed for coolant to run through center of drill, should be used submerged with coolant.

No matter what type of diamond drill or coolant applicator is used, the amount of coolant used should increase with the hardness of the material being drilled. Sparks during the drilling operation indicate that insufficient coolant is reaching the drilling zone or that the type of coolant being used is ineffective for that application. **A generous flow of coolant increases the diamond drill efficiency and reduces heat buildup, thereby reducing the material cracks and deformation associated with overheating.**

Strong coolant pressure will also wash out any material debris (center plugs) that becomes stuck in center of your drill. Center plugs restrict coolant flow to the center of the drill and prevent coolant from reaching the diamond section. As a result, your drill will start to drill dry, significantly reducing the drill life and material surface finish and deteriorating the overall drilling operation. Center plugs are behind 90% of all drill wreckage.





Balancing Drilling Speed & Pressure

Drilling speeds are affected by the hardness and abrasiveness of the material, the age and condition of the equipment, and the amount of pressure and coolant used. The only real way to develop the right drilling process for a given application is through experience. If you are new to diamond drilling, you should start at **low speeds and low pressure with large amounts of coolant** to minimize the risk of drill and material damage until you can build your experience using a specific diamond drill, setup and application.

Drilling Depth

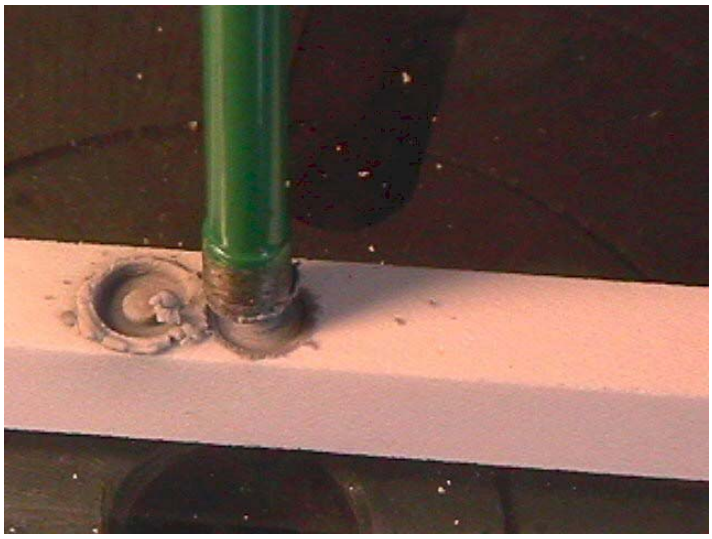
Most drilling applications require drilling depth of not more than 1”. Applications requiring you to drill over 1” should be tread in a different way. We recommend running coolants from multiple directions. Through drill center, from side of drill, as well as drilling submerged in coolant.

This will insure maximum amount of coolant and lubrication reaching your drilling zone. Apply more pressure and reduce speed the deeper you penetrate into your material. Lift drill up, inch drilling into your material, letting the drill cool and coolant reach deeper into your hole. Carefully examine the diamond tip condition, making sure its round, and not overheated.

Your maximum drilling depth will also be limited by spindle travel. The distance your drilling equipment can move in an upward and downward motion before touching the surface of your material. Make sure to take this into consideration when ordering diamond drills.

Dressing Diamond Drills

Most diamond drills can be dressed (re-trued) several times to extend their useful life. Never assume because your diamond is new, that it does not require this operation. The wear on the diamond drill depth usually takes place on the drill core and diamond section, as well as on the wall thickness. A diamond drill can be dressed using a dressing stick or a used silicon carbide wheel to the point where the wall thickness is standard.



While dressing can improve the drill's accuracy, it can also cause diamonds to be pulled out from the drill diamond section (diamond tip). You can re-expose the diamond section by drilling into an Al_20_3 stick a few times after the dressing operation.

Small Diameter Drills

Small diameter diamond drills must be used at significantly higher speeds than larger size drills. It has been found that **higher Revolutions Per Minute (RPM's) improve surface finish and overall drilling performance**. RPM's for diamond solid drills .001" to 2.5mm (without center hole for coolant flow capabilities) range from 9,000 to 450,000. Drilling equipment that can accommodate these speeds include: high speed air spindles, hand held drills, and other specialty micro drilling equipment. High speed air spindles can run up to 450,000 RPM, hand held drilling machines to 35,000 RPM, and specialty micro drilling equipment up to 25,000 RPM.

All diamond solid drills and diamond micro drills must be used with coolant. We recommend either drilling submerged in coolant, or applying air as coolant (in some cases), if other liquid coolant types cannot be used. Smaller size diamond core drills 1.6mm to ½" (mounted on a collet with thread and designed to run coolant through center of drill) must

run with **high pressure of coolant 45 PSI through center of drill**. This is the key successful drilling very hard materials. Drilling submerged in coolant is not recommend. Once the core (material debris) becomes stuck inside the drill, coolant is blocked off from the drilling zone, and the drill can no longer be used.

It is very important that you **periodically check the inside of the drill for material clog up**. If you spot the material core becoming clogged up, flush out this debris using coolant pressure from a water swivel adapter or other coolant source. Continue drilling only after the debris has been removed.

Diamond Drill Maintenance

Proper diamond drill care and maintenance is very important for optimum drilling performance. Maintaining the diamond section shape and rigidity is important to prevent the drill from loosing its sharpness and roundness. Make sure to repeatedly dress and retrue the drills diamond section to rexpose new diamonds. If you see the diamond drill has lost its shape or rigidity, send it back to the manufacturer to be retrued.

Evaluating Diamond Drill Performance

There is various criteria for evaluating diamond drill performance. The importance of each variable will depend on your requirements. **Diamond Drill Life**, an important variable for many high production drilling operations, can determined by the number of holes a drill can produce.

Drill life is affected by various factors such as: material being drilled, bond type, coolant used, drill manufacturer, operator experience, age and condition of drilling equipment, and etc. You may find estimating diamond drill life a fairly difficult process. **Precision tolerances and Surface Finish Quality** also remains an important consideration for drilling many materials. In this case drilling performance is evaluated amount of chips generated on the face of material.

A visual check is just about the only way of checking finish quality. Another factor you want to consider is **diamond drill break in time** and frequency of dressing. All diamond drills require time to break in, to produce relatively chip free performance. The period of time under witch this occurs, separates one diamond drill from another.

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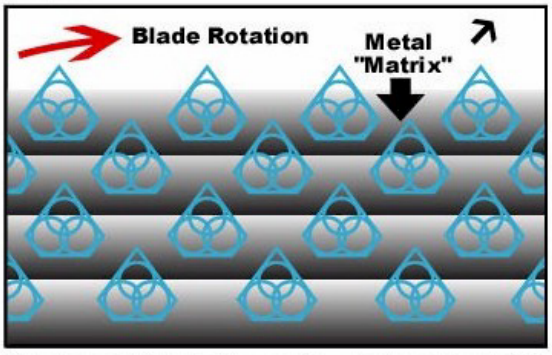
The sharpest and finest quality DeBeers diamonds that go into a Smart Cut Diamond Bond, immediately penetrate into the material, grinding and polishing as they cut.



Diamonds are activated only at the exposed layer. As diamonds layer begin to wear out, diamonds in a new diamond layer are immediately activated, substituting the already used up diamond layer. The Smart Cut Diamond Bond makes sure every diamond is in the right place and at the right time, working where you need it most.

http://www.ukam.com/diamond_tools.htm
Getting most from your Diamond Tools