

**COMPOSITE ENVISIONS KNOWLEDGE HUB
PRACTICAL AND INSIGHTFUL COMPOSITES INFORMATION**



CUT QUALITY FROM VARIOUS CUTTING TOOLS



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COMPOSITE CUTTING TOOLS REVIEW

INTRODUCTION

When trimming or cutting any cured reinforced fibers, all cutting edges of the tool are going to be dulled quicker than they would when cutting wood or metals. It is the abrasive nature of composite materials. Composite materials carry residual heat along the surfaces in which are cut. If proper care is not taken the results can lead to poorly trimmed edges, a headache from how slow an improper process can be, and worse, possible delamination of the composite's structure. Delamination is caused by separation between the composite fabric layers. This causes the part to fail structurally in compression. Delamination defeats the purpose why multilayered composites are made in the first place. However, there are an array of tools that can be selected to ensure all composite parts can be effectively cut and trimmed to needed parameters after cure.

Practice makes perfect, it is suggested to use scrap parts or other surfaces to effectively vet any new tool or cutting blade used. Different brands of tools may have attribute differing speed, sharpness, thickness characteristics, thus cutting differently than others. While no brand may be definitively better than the other, having experience and practice with a given tool will yield better results.

Safety note: While cutting / drilling / sanding any composite, wearing proper protective equipment (PPE) is important. Composite dust is an irritant. A mask or respirator will keep composite dust from possible irritation of throat and lungs. A sleeve will keep the dust from coming in contact and irritating skin. Properly sized, cut resistant gloves will provide peace of mind and allow for precision while using tools for cutting.

Please DO NOT forget safety glasses and ear plugs. In addition, a shop vac with vacuum hose placed near or under the trim area will aid in mitigating any dust caused by cutting or sanding laminate edges if a down draft booth is not available. A "shop" fan can also be used to push particles and dust out of the area that otherwise may be lingering or suspending in the area.

Tip: While trimming laminates, dust or particle accumulation incoming to face or skin may be mitigated by simply swapping the direction of circular bits. If possible, have the diamond wheel or sanding block going into the laminate, down or away from whom is performing the cut. This will mitigate pieces and particles being cut from the part that would otherwise be aimed toward hitting the neck or facial areas. Clear face shields are also utilized to eliminate issues when chips or pieces of laminates possibly coming back toward the face.

When cutting or drilling any composite part, blades or bits should always be sharp. Heat dissipation while cutting is the biggest challenge when cutting most composite laminates. Dull blades or cutting surfaces only add to the amount of heat placed on the laminate surface. Using a sharp blade will increase productivity and provide a more accurate cut.



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GRINDERS & ROTATING TOOLS

Pencil Grinders, Right-Angle Grinders and even routers offer the most superior support when cutting through Carbon Fiber, Kevlar, or Fiberglass composites by hand. These tools range from pencil grinders and dremels that fit neatly in hand to bigger and more powerful right-angle grinders and routers. Rotating tools offer a versatility that is unmatched by other tools. Whether the laminate is curved, is locked by tight spaces, thick or thin, a rotary tool with the right cutting surface will provide a confident cut and a quality laminate. For hand cutting purposes, a router is not recommended as most router bits are extremely hard and brittle. Use of a CNC machine for use of routing are preferred for this method of cut. It is important to note that trail and error are common when cutting any laminate surface.

Pencil grinders or straight die grinders are used widely for cutting laminates of great variations and thicknesses. There are multiple attachments that can be used to polish, cut, sand, and prep composite laminates. The handheld tool uses a rotating spindle at its front and uses high speeds to perform needed tasks. Dremel tools are also commonly referred to as pencil or die grinders and are the same “type” of tool. Dremel, a brand of a tool, is commonly used to perform the same types of work on a composite laminate. While Dremels / die grinders / pencil grinders are the same type of tool, some apparent differences should be noted. Die grinders are generally larger in size and have more power to cut through thicker laminates. Honing the power usually takes use of both hands. Dremels are weaker but are easily held with one hand and have faster rotation. Dremels also variate speed easier, with just a push of a button.

The bulk of heavier cutting is more effectively performed using a die grinder that is pneumatically powered. Needs requiring a quick “touch-up” or where precision is needed, using smaller bits or files with a Dremel will allow the user more versatility with a laminate, getting into tighter areas where finer precision may be needed.

Right-angle grinders are like straight grinders but have a head that is perpendicular to the body of the tool. Right angle grinders can be used to cut through laminate surfaces but are most used to perform final sanding and prep for secondary bonding purposes. These grinders may also allow for getting into tighter to reach places where a straight die grinder may not fit.

When selecting a grinder or rotating tool, options between electric and pneumatic power are usually a top question. It is important to note that speed does not equate to power. Torque behind a slower rotating pneumatic tool will take much more laminate to “stop” a blade from spinning. As with a smaller electric option, they can be stopped or slowed much easier by thicker laminate pieces. Though most electric options usually need to be plugged in, cordless models are available for an additional price. Electric grinders are generally less powerful than pneumatic powered tools but are usually lighter and faster, like a Dremel. Cordless options do provide an advantage in portability as they will fit in the most compact areas. Pneumatic



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tools are known for providing the needed power and torque for any job. They are generally much cheaper but require an air compressor for use. Pneumatic tools also take more practice to master precision cutting needs as they carry more power. It is common to perform over cuts of 1/4" or greater while using pneumatic grinders for initial cutting of parts. Afterward, going over the same areas with a right angle grinder with a abrasive sanding bit to achieve a close / final finish as required per dimensional needs.

DIAMOND WHEELS & TUNGSTEN CARBIDE

Special bits or blades are needed to cut most composite materials. A Diamond Wheel provides significant advantages for cutting through most any laminate edge, as diamond is harder than any other cutting material. Tungsten carbide cutting blades will cut laminates as well but will only provide a sharp cutting surface for half that of a diamond coated blade. (Tip: The thinner the cutting blade, the easier it will be to get through any laminate.) For diameter sizing of the blade, smaller diameter blades (1/2 - 1") will dull quicker, however will allow for tighter dimensional criteria whereas a larger blade (2-5") may last longer but may not get into tighter areas. For almost any tough or thick laminate, a diamond wheel attached to a rotary tool is by far the best option when cutting any given composite edge.

BAND SAWS

A band saw is commonly used in industrial processes as available. Though the band saw is used ideally to cut metals they can be used to cut composite laminates that are flat or need straight cuts. Fences and other locating features are generally used to provide dimensional stability for laminates when a straight cut is preferred. Many band saws come equipped with a coolant aid or bath. As the large diameter blades carry from the cutting surface, they are dipped into a coolant bath below. Band saws are affected less by heat as the blades are exposed to coolant between each cut through the parts surface and are not exposed to the composite's material as often (per surface area). Metal cutting blades with small teeth are generally used with a band saw for cutting composite materials. Using a band saw is an option when cutting panels or performing straight cuts into small intricate parts for quality needs. It allows to keep the parts cutting surface cool even through cutting thicker pieces. It is also good for repeated cuts as when the part is set on the "fence" or locating tool, it can be cut again without pause for heat placed on the blade surfaces.

JIG SAWS

Although primarily used best in wood cutting applications jig saws are also an option for cutting fabricated laminates. Challenges with Jig saw on a composite application are that they are prone to cause edge damage on laminates due to a back and forth motion while cutting. A rotary cutting tool has a higher surface area in which the cutting surface can dissipate heat as the smaller surface area of a jig saw blade does not. This lack of surface



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causes the cutting blades to heat at a faster rate. This heat is transferred to the laminate and can cause edge delamination. Without the use of special composite cutting blades or use of metal cutting blades, a jig saw will not cut a composite effectively. Even with carbide grit blades made for cutting composites, service of a jig saw is still mostly limited to flat sheets. When using a jig saw, it is advised to cut well beyond the desired final edge of the part and sand down the laminate to the desired cut line. Use of a 60-80 grit diamond or carbide abrasive blade will yield the best results when choosing to cut with a jig saw. In addition, a jig saw equipped with a vacuum attached to it or close by will help control dust.

Body saws, or saws-alls are very similar to Jig saws. A simple back and forth motion of a blade contacts the part. It shares the same advantages and disadvantages as the jig saw although more complex parts can be cut from a body saw as it is not fixed such that as a jig saw is. The blades instead come out of the tool parallel instead of perpendicular to the tool's surface.

CNC CUTTING

In high volume or where a high degree of quality control is needed, automated or "CNC" routing composites parts or molds may present the most viable cutting option. CNC (Computer Numerical Control) technology uses software to automate cutting processes for countless manufacturing markets today. When used in composites they provide repeatable processes to trim, drill, and routing operations by using numerical and alphabetical coding to control movement of a given machine's cutting tools. CNC machines are programmed to run by a "G-Code" controlling factors such as the feed rate, coordination, location, and speed of the machine.

Two of the most popular machines used in composites today are CNC controlled mills and water jets. The same concepts learned using hand tools provide a means of cutting a quality composite part with a CNC machine. Rotating tools with diamond wheel or tungsten carbide materials are commonly used to cut composite parts. "Feeds & Speeds" is of utmost importance for the cut quality in composite parts. It is imperative to have a working knowledge of the Fabric and Resin systems, knowing that most composite parts are best cut with a high rate of speed for the bit and doing this at a slow feed rate. With a CNC water jet, a stream of abrasive water is shot through the part at a given feed rate, leaving the cut in the desired path on the part. The speed and feed rates are highly dependent on the thickness and material of the laminate.

Overall, CNC machining has revolutionized the composite industry. Other than providing highly precise cutting and machining of composite parts and molds, CNCs make secondary composite processing a breeze in comparison to older methods as it can eliminate the need for many complicated trim, drill and assembly jigs.



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WATERJET

A waterjet cut provides a cut from a finely adjusted abrasive line of water with additives to aid in the cutting process. A waterjet is known to minimize time for secondary finishing and allow a high variation in the different thicknesses it can cut through. Rather than friction cutting, a water jet abrasive cut mitigates opportunities for delamination. Programming allows for tight dimensional tolerancing throughout cuts at hard angles and can lower costs associated with trim tools. A waterjet will usually produce a smoother finish than that of rotary tools as its surface speed is much higher. Waterjets are commonly used to cut ~95% of a laminate's dimensional criteria. However, machining processes such as countersinking, drilling, and surface milling are outside of the waterjet's scope.

Pierce through delamination issues can occur when initially cutting a "window" or larger hole out of a given laminate. In order to eliminate this problem, a "starter" or pilot hole should be mechanically drilled before making the cut through. Afterward, the waterjet can be placed into the pilot area for cutting to resume. Upfront costs associated with buying and commissioning a waterjet will be at least \$5000 for a desktop version but can go up to more than \$200k on more advanced 5-axis machining models.

WET VS. DRY CUTTING

When given the option, wet cutting of a laminate offers the advantage of keeping a laminate's surface cool during cut. In industry today, CNC routers use coolants to aid when cutting through laminates during machining. Keeping the laminates surface cool makes all the difference when cutting larger and thicker laminates. Water is generally used as a coolant and will also aid in keeping dust away from the cutting surface and surrounding areas in which people may be exposed to inhalation hazards. Although other coolants may be used, water is generally an industry choice due to other coolants' possibility of introducing contaminants to the part, especially in secondary bonding processes. Coolants with any rust inhibitor should not be used as they will degrade Carbon Fiber.

There are challenges to wet cutting a composite, such as an efficient means of supplying water to the surface of the laminate. "Spraying" water onto the surface while cutting is neither efficient nor safe. To overcome this obstacle, wet blade cutting kits are available as an addition to most grinders or right-angle sanders. Some minimal modifications may have to be made to existing rotary tools. However, this will ensure the most efficient cut and prolong the life of cutting blades.

SANDING & FINALIZING CUTS

After utilizing the cutting blade to get a near net cut, wet sand the laminate edges with a fine grit sandpaper or light abrasive pad to achieve final part dimensions. Wet sanding can



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be performed by hand or with a right-angle grinder /pencil grinder attached with circular sanding disk or other media such as “scotch brite” red, gray, or white. Grit size may vary slightly per user, but for part quality ~600 grit is a good starting point. Use of a hand block sander in a back and forth motion will aid in this process when detail is needed for tighter dimensional tolerances. Wet sanding edges will keep heat away from the laminate edge to prevent possible delamination of cured edges and mitigate dulling of blades / bits. Larger “sanding wheels” may also be used as needed but are stationary and are limited by mobility for use.

SCOTCH BRITE BITS

Circular scotch brite bits can be used with right angle grinders / sanders to sand away small areas during finish sanding. These bits are commonly screwed into the end of right-angle grinders. Scotch brite pads come in assorted grit and diameter sizes. Some are made for high abrasive content (usually red in color) and others that are less abrasive and can be used when only needing to touch up given areas or provide differing surface finishes for prep on laminate surfaces (usually green / white / grey in color).

USE OF ~180-220 GRIT SANDPAPER

180-220 Grit sandpapers are generally used on right angle grinders to sand away parts initially cut diamond wheels or other cutting tools. After parts are cut to near net dimensional tolerances, the 180-220 grit sandpaper bits are used to get to the final dimensions when hand-controlled cutting means are used.

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