Decatur Diamond

# Glass Fiber Composite Machining

CVD coated diamond tools are a perfect match for machining glass fiber composites. The very abrasive characteristics of composite materials severely limit the life of both carbide and PCD diamond tools.

Tools with diamond on the surface wear longer and have a lower coefficient of friction. These characteristics provide substantial benefit to machining operations.

Because CVD diamond tools last 10-50 times longer than carbide tools, and 3-4 times PCD diamond tools they:

- Improve dimensional accuracy and consistency of machined parts
- Greatly reduce number of tool changes, increasing productivity
- Increase machine utilization
- Allow for unattended machine operations
- Quickly pay for themselves

The low friction of CVD diamond tools permit using speeds higher than both carbide and PCD – again contributing to higher productivity – with no degradation of the surface quality or tool life. The consistently sharp edge and lower friction allows delicate, thin wall sections to be machined quickly and precisely. The sharp and long wearing edge also puts lower stresses on the part, fixturing, and equipment. Since CVD diamond has no cobalt binder to break down or abrade away they offer the longest possible tool life.

Glass fiber composites can be machined successfully with diamond coated endmills if resin melting and chip evacuation are carefully controlled. Observance of the following guidelines should yield tool lifetimes of approximately 10 times the equivalent carbide tool.

**Resin Melting**: speeds and feeds must be adjusted to avoid melting or softening the resin in composite materials. This means that feeds must be 0.001” ipt or greater with larger diameters and speeds should be kept at 400-500 sfm for G10 or FR4 type materials. As the depth of cut increases the cutting speeds should be reduced to below 400 to minimize heat buildup in the chips. For shallow depths of cut, feeds can be up to 0.010” ipt for 1/2” diameter tools. Maximum feed rates are a function of the depth of cut and limited by the tool strength for a given diameter.

**Chip evacuation**: for slot depths exceeding more than 1/2 the diameter of the endmill the evacuations of chips from the slot becomes extremely important. Failure to adequately remove chips can cause breakage of the carbide under the diamond film on the flute edge and subsequent catastrophic failure of the tool. The use of 2-flute tools and moderate-to-high feed rates is highly recommended to insure good chip flow. Air flow into the cut and vacuum evacuation of chips from the cutting area are also recommended. Additional life improvements can be obtained by using a corner radius or ball end tool for the initial cut and then following up with a square end tool with a much shallower cut to achieve the final dimensions. For side cutting applications there is also an issue with chip evacuation if the radial depth of cut exceeds 1/4 of the tool diameter for a 4-flute tool or 2/3 the diameter for a 3-flute tool. Maximum tool life and

production rates are generally achieved with 2-flute tools operated at high feed rates for most side cutting applications.

Machining Parameters: recommended parameters for **sidecutting** are listed in the following chart for various flute configurations. Recommendations are based on a cutting speed of 400-500 sfm and a diameter of the tool greater than or equal to the material thickness. Larger radial depth of cuts are possible if the material is substantially thinner than the tool diameter.

| **Starting parameters for sidecutting glass fiber composites** | | | |
|---|---|---|---|
| **Tool Configuration** in. (mm) | **RDOC %** (max radial depth of cut % of diameter) | **Feed Rate** inches/tooth | **Cutting Speed** sfm |
| 4-flute, 30 deg helix | 25% | 0.001-0.004 | 400-500 |
| 3-flute, 30 deg helix | 65% | 0.001-0.004 | 400-500 |
| 3-flute, 30 deg LH spiral RH cut | 100% | 0.001-0.010 | 400-500 |
| 2-flute, 30 deg helix | 80% | 0.001-0.010 | 400-500 |
| 2-flute, 30 deg LH spiral RH cut | 100% | 0.001-0.010 | 400-500 |

Machining Parameters: recommended parameters for **slotting** are listed in the following chart for various flute configurations. Recommendations are based on a cutting speed of 400-500 sfm and a full width slot which does not penetrate the full thickness of the material thickness. See sidecutting chart for slots which penetrate the full material thickness.

| **Starting parameters for slotting glass fiber composites** | | | |
|---|---|---|---|
| **Tool Configuration** in. (mm) | **RDOC %** (max vertical depth of cut % of diameter) | **Feed Rate** inches/tooth | **Cutting Speed** sfm |
| 4-flute, 30 deg helix | 50% | 0.001-0.010 | 400-500 |
| 4-flute, 30 deg ball nose | 150% | 0.001-0.010 | 400-500 |
| 3-flute, 30 deg square w/radius | 80% | 0.001-0.010 | 400-500 |
| 3-flute, 30 deg helix | TBD | 0.001-0.010 | 400-500 |
| 3-flute, 60 deg helix | 120% | 0.001-0.010 | 400-500 |
| 2-flute, 30 deg helix | >100% | 0.001-0.010 | 400-500 |

Note: VDOC's greater than 100% of the tool diameter are listed for informational purposes only and are not recommended for normal operation