

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



**BONDING COMPOSITES
TO METAL AND OTHER
SUBSTRATES**



***COMPOSITE
ENVISIONS***



INTRODUCTION

As part of composite processing, it becomes necessary to bond pieces of composite laminates to metal, such as steel, aluminum, other composites and other various substrates. Processing requires multiple steps to achieve a successful adhesion or bond between an array of components. In general, the following steps should be followed for bonding to metals and wood to cured composite surfaces:

Surface preparation for secondary bonding of composites can start with the laminate cured or during the last layup sequence of the composite.

(Optional) During layup: An option for surface prep as the final layer of composite fabric is placed upon the tool, a thin sacrificial layer of woven fiberglass may be applied on top the existing plies in which the secondary bonding process will occur after cure. This is not mandatory to all processes but will mitigate the chances of fiber damage to the underlying plies during surface prep during secondary bonding.

Important Note: When bonding metal parts to carbon fiber, a layer of fiberglass should be used to provide an isolating layer between conductive Carbon Fiber fabric layers and the metallic parts being bonded. Galvanic corrosion between dissimilar materials, such as Aluminum, Carbon Steel, and some Stainless steels can occur on metallic parts directly placed in contact with Carbon Fiber. The electrically insulating fiberglass layer between the Carbon Fiber and metal will serve as a disconnect between the 2 parts.

There are options for “peel ply” to be placed on top of the final ply’s surface to provide a consistent, non-gloss surface finish to the cured composite. Upon cure and removal during stripping, peel ply use will provide a better surface for bonding and mitigate excess surface resin on the composite during cure. Peel plies will work on most any composite curing method.

Once the composite component is stripped from the mold, sharp edges have been de-flashed, and trim processes completed, it is best practice to clean the composite of any potential foreign debris or oils accumulated during any of the above processes using a cleaner such as Isopropyl Alcohol or Acetone.

PRE-CLEANING

Remove all contaminants from the repair area and ensure a clean working surface for secondary bonding. The surface preparation process is the most important piece of secondary bonding. It is used to increase the surface area of the 2 bonding components and maximize its potential for a lasting chemical bond. Simply cleaning the area will not allow for the adhesive to “grab” onto the parts’ surfaces during the cure process.



BONDING COMPOSITES

Items Needed: 220-400 grit sandpaper or red scotch brite pad, isopropyl alcohol (cleaning), lint free cloth, latex/nitrile gloves

(Using a 60 or 80 grit sandpaper will likely be too abrasive and cause fiber damage to underlying plys on composite component) On metal components it is not as important that the higher grit is used.

Note: If a shop vac is handy it is advised to use during sanding process to keep the area clean of debris as resin is sanded away.

PRE-FIT

Place the 2 components together in which they will be placed together in the future. This will ensure proper fit of components and to get an overall understanding of any fixturing or additional tooling that may be needed in the future for holding pieces together during cure processes. Mark area and place masking tape or Flashbreaker tape (~.100”) beyond bonding surfaces. This will provide a means of locating which areas to prep and which do not need attention.

METAL COMPONENTS

Sand / Scuff planned bonded areas of both surfaces lightly using chosen abrasive. For metal parts such as steel and aluminum sand until reflection is gone using red scotch brite or sand paper ranging from 220-400 grit. Clean and Water break bonding surfaces as described below.

COMPOSITE COMPONENTS

If bonding with a carbon fiber composite, sand until the surface starts to blacken, as the CF plys will be exposed. DO NOT go beyond this depth. For Aramid and Fiberglass components, it can be more difficult to tell when sanding into the fibers. With Kevlar, if a frayed like surface is evident, Kevlar fabric layers have been sanded into, which should be avoided.

As a best practice sand until any gloss or “flash” from the cured composite surface is gone. Composite components prepped for bonding should be a dulled like surface when dry. If light reflection is evident, continue to scuff the surface. Sanded areas will usually be a lighter shade than un-sanded areas.

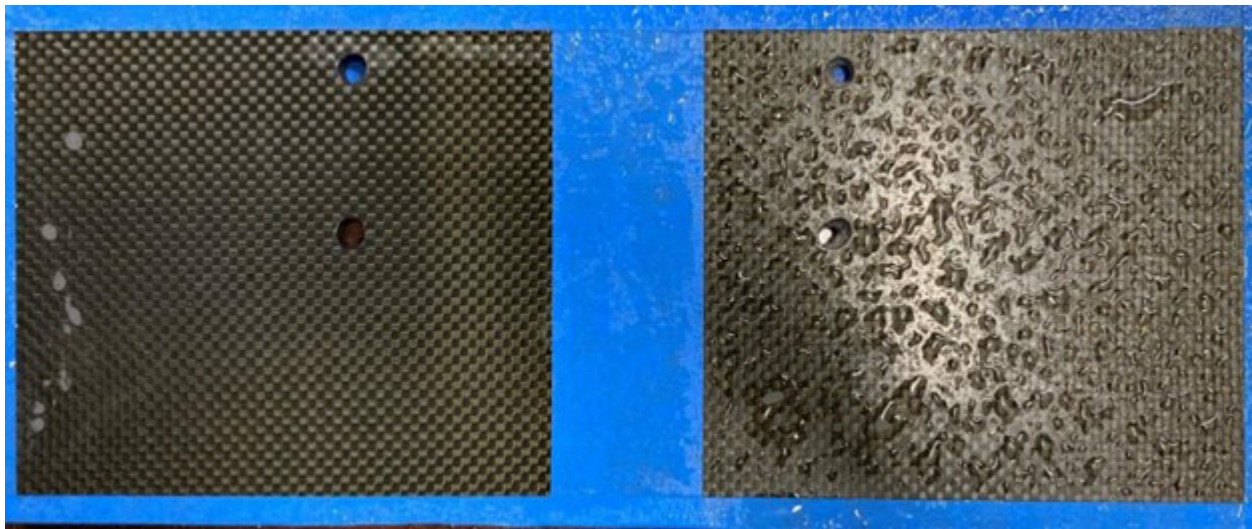
Wipe bonding surfaces using a lint free cloth drenched in alcohol until clean. Best practice is to fold the cloth into four sections and wipe once across the surface on each clean section until no dust or loose resin is picked up. On the last swipe of each component, there should be no evidence of contaminants on the lint free cloth.



WATER BREAK TEST (QUALITY CHECK FOR BONDING PREP)

Although a crude test, water break testing is used as a simple means to ensure bonding surfaces are ready for secondary bonding adhesive's application. A passing water break test will ensure the component surfaces have been cleaned adequately and roughened to provide the needed surface area for composite bonding. A water break test is passed or failed based on a "contact angle" between the water and the composite part and other bonding substrate areas.

A "water-break test" of the prepped area may be performed by using a spray bottle of water. Spray water onto the prepped area. Watch the flow of water onto the prepped area and observe the following characteristics. If observing a smooth flow stream, and beading as it leaves the prepped area, it passes the test. If observing the water will "beading" up on the prepped surface, continued sanding and cleaning is needed.



Left: A passing Water-Break test that is ready for secondary bonding processes. The water holds a steady film over the prepped surface. Almost as if it would be a clear coat to the surface.

Right: Water is beading on the surface of the unprepped surface. If water is beading upon prep, the bond will likely fail.

Upon passing water break test, dry area using a clean-lint free cloth. Then go back over area using alcohol or acetone to ensure there is no presence of water on the part surface.

Optional: Apply masking tape to any areas that will not need to have adhesive applied on it. This is only for general cleanup as some adhesives will run and may cause run out to be



taken care of by sanding means after bond.

SECONDARY BONDING

Note: If bonding to wood or using wood as a bonding substrate, DO NOT use treated lumber or plywood. It will not bond sufficiently to the composite. Non-Treated Wood can be used in secondary bonding successfully. Usually, wood is used as a substrate for laying up fabric and resin over and then allowing to cure. Wood can be secondary bonded to cured components. Use of “Coosa Board”, a high-density polyurethane foam with reinforced layers of fiberglass, would be an alternative option to wood.

An unlimited array of resins and adhesives are used for many secondary bonding and substrate surfaces. For many simple at home fixes, epoxy-based systems will bond to nearly any surface. However, structural or toughened adhesives are recommended for load bearing structures. Structural adhesives are proven to eliminate the need for fasteners on an array of applications. For gap filling or curved / complex surfaces, a thixotropic adhesive will stick to surfaces better than standard “runny” adhesives. It is up to part design for researching specifics from each manufacturer. Each manufacturer may have specific adhesives that work best when used for certain substrates, temperature needs, and strength requirements. Commonly used aerospace and general adhesives can be found in the tools needed section.

Often, different adhesives will achieve needed results based on budget, final use, temperature and structural needs. Note: pot life / working life is important to note in these processes. Allow for needed application time. It is advised to wait to mix until surfaces are ready for application.

Wearing clean nitrile/chemical gloves, measure out needed amount of adhesive of both Part A & B in different measuring cups using a scale. Do not yet mix until ready to bond. (Mechanical / additional pressure for bonding means, if used, should also be in a state that is ready to use) Application of specific adhesive may vary but are mostly similar in mixing a needed amount of part A to B (per volume) Use tongue depressors or paint stick to mix adhesive properly. Apply adhesive to both bonding surfaces using a light brush.

After adhesive is placed onto both surfaces, place parts together. Dependent on how the part is bonded, use of any additional applied pressure is advised, whether mechanical or by gravity. Some options include vacuum bagging, mechanical pressure (such as clamps) or simply placing a sandbag (weighted bag) on top the mating surfaces separated by a release film or equivalent. This will help the bond achieve the goal of keeping substrates together for its designed purpose. Without added pressure, the bond may not seal properly or to needed quality specifications.

Cure adhesive to manufacturers specification. Note: some oven cured adhesives may exceed the service temperature for some room temp cured epoxies or plastic resins. Detail in



adhesive selection is critical to the process of secondary bonding.

Once cured, remove any masking and clean excess areas with alcohol and / or perform light wet sanding as needed. Use care to not cause any fiber damage.

ABS PLASTIC BONDING

With ABS plastic bonding, the process is a little less straight forward. ABS plastic is almost like bonding to a release agent. While it is not best practice, it is chemically possible to bond substrates to ABS plastic and achieve satisfactory results. Many of the epoxy-based systems will work for bonding various substrates to plastic.

SANDING METHOD

Degrease the plastic surface to remove loose contaminants from the surface. Most commonly this can be achieved by using a lint free cloth soaked in isopropyl alcohol. Best practice is to fold the cloth into four sections and wipe once across the surface on each clean section until no dust or loose resin is picked up.

Lightly abrade the surface with 220 grit sandpaper. The goal is to achieve a slightly roughened surface without causing any damage to the plastic. After abrading the plastic, remove all contaminants using a lint free cloth soaked in acetone or isopropyl alcohol. Perform a water break test as described above. Clean and apply chosen epoxy-based adhesive as shown in secondary bonding procedure above.

ABS FLAME TREATMENT METHOD

Remove dirt or loose contaminants from the surface. Using a flame from a torch or other gas flame, expose the plastic to the flame for a few seconds to oxidize the surface and to react with the surface of the ABS resulting in a higher surface energy for bonding. Care should be used to not allow the surface to be charred or to deform or warp the plastic.

Allow the surface to cool and perform a water break test as described above. Clean and apply chosen epoxy-based adhesive as shown in secondary bonding procedure above.

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