Carbon Fiber Driveshaft System - Aluminum to Carbon Fiber Tube Bonding Procedure
Neapco Performance Series
Bonding Process for Carbon Fiber Driveshaft Systems
Composite Tubes and Metallic End Components
Tips and Best Practices -
# Table of Contents

- Disclaimer .................................................................................................................. 3
- Tools Required .......................................................................................................... 4
- Consumables Required............................................................................................... 4
- Surface Preparation .................................................................................................. 5-7
  - Tubes ...................................................................................................................... 5, 6
  - Ends ......................................................................................................................... 7
- Driveshaft Assembly .................................................................................................. 8, 9
- Bonding Process ........................................................................................................ 9, 10
- Completing Driveshaft Assembly and Installation Preparation ............................. 10, 11
- Additional Best Practices .......................................................................................... 11, 12
- Revision History ........................................................................................................ 12
Disclaimer

Neapco Components LLC, in collaboration with Composite Drivelines LLC has developed this bonding procedure to securely bond aluminum and steel components to the ID of composite driveshaft tubing. Since this bonding technique relies on chemical bonding versus traditional mechanical fastening, surface preparation and cleanliness are critical to a successful bond. Any deviation from this process, including failure to use the identified tools and consumables listed below, will result in weaker and less consistent adhesive bond strengths, bond failure, and will void any applicable warranties. Use of any expired adhesives or surface treatment chemicals will also negatively impact bond strength and resilience.
Tools Required

- Pneumatic or manual hand-held adhesive dispenser
  - Neapco Part # NPCF-MANDISP-50ML is a handheld squeeze dispenser for 50ml adhesive tubes
  - Neapco Part # NPCF-AIRDISP-400ML is a pneumatic powered dispenser for 400ml adhesive tubes
- Industry standard press-up tool (i.e. driveshaft press, vertical press, or lathe)
- Linear measurement tool (i.e. tape measure)
- Saw to cut carbon tube to length
  - Diamond wheels for tile or concrete with a solid, continuous edge required.
  - Abrasive wheel chop saw can be used. However, the cut edges will need additional finishing to smooth edges.
- Safety glasses with side shields.
- Respirator(s)
  - N95-style mask acceptable for tube cutting dust particles
  - P100-style NIOSH approved respirator for organic vapor (OV) strongly recommended for cleaning and bonding.
- Shop sink with hot water
- Uncoated 5/32” specialty drill bit for carbon fiber, ref: McMaster-Carr PN 2828A73

Optional Tools if Seeking Accelerated Cure Time

- Large insulated heat source (i.e. oven)
- Laser temp gun

Consumables Required

Neapco offers several items listed. Noted items are stocked and competitively priced.

- 3M DP-460 Epoxy, Off-White
  - Neapco Part# NPCF-ADHESIVE-50ML is a 50ml tube of DP-460 adhesive for hand-held dispenser
  - Neapco Part # NPCF-ADHESIVE-400ML is a 400ml tube of DP-460 adhesive for pneumatic dispenser
- Henkel Bonderite® M-NT 1455 W
  - Neapco Part # NPCF-METALPREP-50W is a 50-ct pack of pre-saturated metal prep wipes
- Loctite® SF 7617
  - Neapco Part# NPCF-TUBEprep-75W is a 75-ct pack of pre-saturated carbon fiber tube prep wipes
- Compatible adhesive mixing nozzles (single use, disposable, mixing nozzles to blend and extend adhesive life)
  - Neapco Part# NPCF-MIXNOZ-50ML-50PK is a 50-ct pack of mixing nozzles for 50ml adhesive tubes
  - Neapco Part # NPCF-MIXNOZ-400ML-50PK is a 50-ct pack of mixing nozzles for 400ml adhesive tubes
- Acetone w/appropriate spray dispenser, ref: McMaster-Carr PN 1427N36
- Suitable acetone resistant latex gloves
- Disposable No-lint shop towels are critical. Traditional red, blue, etc. cloth shop rags are NOT suitable
- 3M Scotch-Brite™ abrasive pads (recommend 3M maroon pads, PN 64659)
- (Optional, but advised) Electronic duster compressed gas dispenser
- Stainless steel pipe cleaners for 3/16” (5mm) hole, ref: McMaster-Carr PN 7353T715
- ¾”-1” wide light-duty filament tape, ref: McMaster-Carr PN 7623A64
Surface Preparation

Tube Surface Preparation

For Use with Ported Tube End Components

1. CRITICAL: Prepare build area by cleaning thoroughly, ensuring work surfaces are completely free of oils and debris. If using compressed air, systems must be equipped with a dryer and filtration system to ensure air is free of oil and water.
2. Prepare operator with required PPE.
   • Safety glasses
   • Chemical resistant gloves
   • Respirator
3. Cut the tube to the appropriate length using a recommended blade style. To reduce dust, a wet saw is recommended. Cut end should be free from any burrs or protruding fibers. If there are burrs or fibers clean end using a file, emery cloth, or Scotch-Brite™ pad.
4. Rinse ID with water to remove any residual carbon dust from the cutting operation. Pass clean shop towel(s) through the tube until minimal debris from the tube is found on the shop towel.
5. Thoroughly clean ID of tube with acetone and no-lint shop towel. Spray acetone onto the no-lint shop towel to avoid having acetone run down ID of tube. Make sure to clean the full bond area (length of section inserted into tube). It is recommended to use a fresh, clean, no-lint shop towel with each of the wipe downs. Reposition or replace cloth and repeat wiping process until the cloth remains clean. Three or more cycles are commonly required to remove all contamination from storage, shipping, and cutting dust and debris. When completed properly, the towel used should be completely free of any carbon dust, and there should be no towel lint on the inside of the tube.
6. Repeat Step 5 on other end of the tube.
7. Using the Loctite SF 7617 wipes, thoroughly wipe the bond area on both ends of the tube and allow to dry. As long as the towel remains moist and clean, it can be used for both ends of a tube.
8. Tube is ready for bonding. Please set aside until mating components are prepared. Ensure that the ID of the tube will not be touched or encounter any contamination risks.
   • Cover ends of tube with a clean no-lint shop towel to prevent any dust from entering the tube while preparing the ends for bonding.

IMPORTANT: ASSEMBLY SHOULD TAKE PLACE WITHIN 30 MINUTES OF CLEANING THE BOND SURFACES.
Surface Preparation (continued)

For Use with **ONLY** Neapco brand Non-Ported Tube End Components (Injection Through Tube Wall)

1. **After cutting the tube to length, but prior to using the cleaning instructions above** (Tube Surface Preparation – For Use with Ported Tube End Components), two adhesive injection holes must be created in the carbon fiber tube.

2. Using the recommended drill 5/32” drill bit, create (2) holes on each end of the driveshaft tube not using a pre-ported component. These holes must be 3” from the end of the tube and spaced 180 degrees (opposite) of each other.

3. If any burrs or loose fibers are present after the drilling operation(s), use a Scotch-Brite™ pad to remove the burr or loose fibers. (see images below)

Once steps 1-3 above are completed, refer to steps 4-8 under Tube Surface Preparation on previous page.

**IMPORTANT:** **ASSEMBLY SHOULD TAKE PLACE WITHIN 30 MINUTES OF CLEANING THE BOND SURFACES**

(more)
Surface Preparation (continued)

Bondable End Components

Ported Designs
1. Blow out both adhesive port holes using compressed air. Neapco strongly recommends use of electronic duster aerosol-type canned “air”. However, filtered, dry, oil-free, and extremely clean shop air can be acceptable. This process ensures there are no machining chips, cutting fluid, or other contamination in the injection holes from the manufacturing process and shipping/storage. Any contamination in the ports will severely reduce bond joint strength.
2. Flush acetone though injection ports and scrub with recommended pipe cleaner. Re-flush the ports with acetone after scrubbing.
3. Thoroughly rinse the inserted / bond area of the tube end component with acetone to degrease.
   • NOTE: If tube end has oxidation present, gently remove the bonding contaminate.
4. Wipe the entire bonding section thoroughly with a Loctite SF 7617 wipe (Part# NPCF-TUBEPREP-75W) and allow to dry.
   • The cleaning wipes can be reused if they are moist and clean; however, Neapco recommends no more than two tube ends be primed with a single wipe to reduce contamination build-up risk.
5. Once dry, thoroughly wipe the bonding area with a Henkel Bonderite® M-NT 1455-W wipe (Part# NPCF-METALPREP-50W) and allow to dry.
   • The priming wipes can be reused as long as they are moist and clean; however, Neapco recommends no more than two tube ends be primed with a single wipe to reduce contamination build-up risk.
6. Repeat for other tube end component.
7. Tube end components are ready for bonding. Set aside until ready to assemble. Ensure that the OD of the inserted / bond area of the component will not be touched or come in contact with any foreign material.
   • If the bond area of the tube end component is touched or comes in contact with any potential source of contamination, repeat step 5 (Bonderite® wiping)

Bondable End Component (Non-Ported Designs)
1. If using Weld Sleeves, perform welding of sleeve and end component prior to cleaning and bonding.
   • Ensure weldment has fully cooled
   • Gently and thoroughly abrade all oxidation and surface residue from the bond area of the sleeve
2. Perform steps 3-7 in “Bondable End Component Surface Preparation (Ported Designs)” section above.

IMPORTANT: ASSEMBLY SHOULD TAKE PLACE WITHIN 30 MINUTES OF CLEANING THE BOND SURFACES
Driveshaft Assembly

Tube Ends

Preparation and Insertion

1. Inspect both the ID of tube and OD of the components’ bond area(s) to ensure there is no dust or other contamination on either part.
2. Prepare the 3M DP460 (Part# NPCF-ADHESIVE-50ML or Part# NPCF-ADHESIVE-400ML) for use in the appropriate adhesive gun you have selected.
   a. Place the adhesive cartridge into the gun and remove cap.
   b. Attach mixing nozzle to cartridge and thread on using grey cap if using manual dispenser. Insert the threaded portion of the cap over the nozzle if using the pneumatic dispenser.
   c. Purge the mixing nozzle of air and unmixed adhesive by dispensing sufficient adhesive out of the mixing tube until it yields a uniform color and viscosity.
3. The DP-460 acts as a lubricant while pressing the aluminum component into the tube. Using a gloved hand, apply a thin film of adhesive onto the ID of the tube. Ensure there is adequate adhesive to fully coat the first 1” of the tube.
4. Making sure not to touch ID of tube and OD of the inserted section of the end component, transfer the tube and the bondable component into a press-up tool. This process follows traditional driveshaft assembly techniques.

(more)
Driveshaft Assembly (continued)

Tube Ends (continued)

5. Begin pressing the aluminum bondable component into the carbon fiber tube. Make sure that the component slides in straight and is not cocked off-center. Only a small amount of force is required to fully seat the tube end components. Small shop press capabilities are sufficient.  
6. Press the bondable tube end component into the carbon fiber tube until the tube end component shoulder stop is fully seated on the end of the tube. 
7. Repeat procedure for the other bondable tube end component on the opposite end of the carbon fiber tube. If end yoke phasing is required, optimize the clocking/phasing of the bondable tube end components **prior** to pressing into the tube. If the phasing is not correct upon press-up completion, slight rotational corrective adjustment of the bond end in the tube is acceptable.

Bonding Process

Adhesive Injection

Ported Tube End Components

1. Once the tube end component(s) have been pressed into each side of the tube, adhesive can be injected into the bond cavity. Ensure the tube is positioned such that the holes are vertically aligned (as shown below). The ports are identical, so a vertical relative orientation is the only position requirement. 
2. Place your mixing nozzle into the lower vent port and begin injecting the DP460 adhesive (**Part# NPCF-ADHESIVE-50ML** or **Part# NPCF-ADHESIVE-400ML**). Continue to inject the adhesive until it begins to bubble out of the upper vent port. Keeping the nozzle in place, pause for 15 seconds to allow for any trapped air to escape. Inject additional adhesive into the lower port until air is fully purged, characterized by the absence of air bubbles through the upper port.

3. Wipe off any excess adhesive with an acetone moistened shop towel.  
4. Place a strip of fiber filament tape over both vent holes to prevent any leakage during curing process.

![Vertical alignment of ports. Inject in lower port for purging through upper port.](image-url)
Bonding Process (continued)

Adhesive Injection (continued)

Non-Ported Tube End Components

Follow the “Adhesive Injection – Ported Tube End Components” section above, but use the holes drilled in the carbon fiber tube instead of the yoke ports shown. Position the shaft assembly with one drilled hole rotated to the bottom, and one on the top. Masking tape can be applied around the top hole to prevent adhesive spill onto the tube. Inject the adhesive into the lower hole in the same manner described above, pausing to allow the air to escape, and continue filling until all air bubbles are purged. Once all air is purged and full adhesive is purging from the top hole, cover both drilled injection holes by wrapping fiber filament tape around the tube OD.

Completing Driveshaft Assembly and Installation Preparation

Curing and Clean-up

1. Natural curing of the adhesives produces less risk to bond quality. The method of curing with a heated environment does work but creates opportunities for assembly errors.
2. **CAUTION- EXTREMELY IMPORTANT:** Adhesive takes 24 hours at room temperature to cure. Do not install Driveshaft assembly into a vehicle for a minimum of 24 hours, unless cured at an elevated temperature (see below for accelerated curing options with heated environment).
   a. If a large oven or heat source is accessible, the accelerated cure schedule below can be utilized. While this “accelerated curing schedule with heat source” allows for a driveshaft to be installed in the vehicle sooner that curing at room temperature, the driveshaft cannot be driven for 24 hours.
   b. **NOTE:** The “accelerated curing schedule with heat source” requires all three of the following steps, in proper order as shown below:
      1) 1 hour at room temperature to set the adhesive.
      2) 2 hours @ 150 degrees F.
      3) 1 hour at room temperature to finish curing and cool.
3. General clean up can be done using shop towels and acetone.

   **NOTE:** Any clean-up of misplaced or unwanted adhesive must be done with acetone BEFORE any curing process. Once the adhesive has been cured, acetone will not remove the adhesive. More aggressive cleaning methods will be required to remove the cured adhesive. Attempts to clean adhesive, post curing, with more aggressive measures could result in visual and performance detrimental damage to the composite tube and driveshaft assembly.

Final Assembly with Additional Complimentary Components

To prevent risk to performance, bonded driveshafts should be allowed to cure for 4 hours prior to final assembly of any additional complimentary components (example: universal joints).
Completing Driveshaft Assembly and Installation Preparation (continued)

Balancing
A. To prevent risk to performance, bonded driveshafts should be allowed to cure for 4 hours prior to balancing.
B. Neapco carbon fiber tubing is manufactured with extreme precision. As a result, the tube is inherently straight and produces very consistent wall thickness throughout the length and diameter of the tube, reducing or removing the most significant causes of tube-generated imbalance.
C. The proprietary bond interface designs greatly aid in the alignment of centerlines, further improving inherent balance. The design does not require the customary precision machining of the tube to ensure yoke/tube positioning and coaxial alignment.
D. Neapco aluminum bond yokes are produced on a state-of-the-art automated machining center. The yokes are specifically designed, forged, and machined to ensure extreme inherent balance.
E. When using a “weld sleeve”, the quality of the fitment of sleeve to end hardware can create imbalance. Additionally, the added density/mass of steel ends yields a significant increase to imbalance risk.
F. Should the final driveshaft product indicate a need for balance correction, Neapco recommends the following methods:
   1. On steel, tack weld conventional steel weld weights. Avoid unnecessarily elevated heating of the hardware as this can damage the bond.
   2. On aluminum, the assembler has the option of tack welding aluminum weights or relieve material on the end component. Neapco advises only slight material removal to balance correction to prevent potentially degrading the product’s strength.
G. Customers should find very little need for balancing of carbon fiber tubed driveshafts.

Installation & Shipping
A. Completed driveshafts can be installed 24 hours after bonding.
B. Shipping driveshafts prior to 24 hours assumes the final curing environment will be acceptable in transport.
C. Driveshaft should be properly wrapped to prevent marring the surface during shipping. Most end consumers of carbon fiber driveshafts are abundantly concerned on the visual appearance of their new driveshaft.

Additional Best Practice Recommendations
A. Cleanliness and consistent practices are CRITICAL to bond performance. Your Neapco tubing and bond designs are designed to hold more ultimate torque and fatigue cycling than the end components available to fit them. We have even designed in a safety factor in the bond design. However, ANY contamination or unadvised preparation and assembly methods WILL result is varying levels of bond performance.
B. Record the following information:
   1. Serial number of the carbon fiber tube. Neapco applies a serialization number to each full-length tube. If pre-cut lengths are used, the serial number may not be present.
   2. Company/Builder of the shaft.
   3. Customer/Application if known.
   4. Relative humidity and temperature during cleaning, press-up, and bonding process
   5. Date of build

(more)
Additional Best Practice Recommendations (continued)

C. Always check the dates and condition of all materials. Outdated adhesives and dried out chemical treatment wipes will underperform to requirement.
D. Duplicate of information sheet can be inserted into the tube prior to end assembly if doing so does not affect surface cleanliness.
E. Wash hands after handling carbon fiber tubing. The material is considered inert and non-toxic, but the fibers fragments from cutting can cause skin irritation similar to handling fiberglass insulation.
F. If fabrication problems or complication problems arise, contact Neapco Product Engineering through Neapco Technical Assistance at 1-800-821-2374, option #4.