

Structural Bonding to Aluminum, Titanium, and Stainless Steel



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Aluminum Bonding Theory:

Traditionally, SSCP has abraded the aluminum oxide layer off of aluminum, used MEK to remove sanding particles, and then glued to this. This works fine, but under humidity/water the oxide layer will creep back under the bond surface and cause the glue joint to crack/fail. This happened with glue joints on Apogee after 2-3 years. In particular, Apogee's door fell off in the prep for ASC 2010.

For Xenith, we used two different operations:

Phosphoric Acid Anodize: this process, defined by a number of different military specs, is used by many manufacturers to provide a very strong, stable bonding surface. If a part has been phosphoric acid anodized, simply MEK the bonding surface, apply structural epoxy, install the part, and allow to cure.

Engineering Drawing Callout, from TYE technical datasheet: **ANODIZE PER MIL-A-8625 TYPE I, CLASS 1**

West 860: This is a two part chromic acid conversion coating. Step one chemically cleans the surface, Step 2 is chromic acid, which etches the surface and places chromium atoms inside the oxide layer, creating a "chromated primer surface." This allows the epoxy to covalently bond to the surface, forming a very strong bond. This is great, except for **chromic acid is highly toxic/carcinogen, and cannot be disposed of easily**. This is why we're switching to the below solution:

Stainless/Titanium Bonding Theory:

Epoxy normally only makes ionic and Van der Waals bonds with stainless and titanium, and is (apparently)shit. Epoxy will **not** form covalent bonds with Stainless or Titanium. Epoxy will absorb moisture, and the internal stress will crack the bond. The glue joint will "pop" in high moisture. This is very bad, and likely to happen in Darwin.

Required Materials

- Clean work surface free of noobs
- AC-130-2 Metal Surface Preparation, available from 3M or online suppliers
- 3M Scotchbrite pads (clean) or grit blasting equipment (180 grit aluminum oxide, relatively clean)
- De-ionized water
- MEK/Acetone
- Lint-free cloth and/or clean air source
- EW5000 AS epoxy primer (Optional, not needed if bonding within 24 hours of ac-130 application and in low humidity environment. Store in refrigerator (DO NOT FREEZE, 35-45 F)
- DP420, DP460, or equivalent Henkel Product Structural Epoxy
 - Check [Pack-n-Tape](#) for competitive prices on 3M products. [Krayden](#) has Henkel products, but they don't always have them in stock. Most other options will either have longer lead times or worse prices than these options. 3M and Henkel Sponsorships can take 4 - 7+ months to process, so start requesting product in January or February after the race. If you start in the summer it will be too late.

Instructions

Surface Preparation for Stainless Steel, Aluminum, Titanium Surfaces only (Not steel, brass, copper, carbon fiber)

1. Clear a work area, put on gloves
2. MEK Wipe with lint-free cloth
3. Abrade with scotchbrite, sandpaper, or 180 grit aluminum oxide blast until water doesn't bead up on the surface.
4. Scrub off the sand with a clean foam brush
5. Clean with De-ionized water
6. Blow off excess water with air
7. **If bonding aluminum, apply AC-130 within 30 Minutes - the oxide layer will otherwise reform**
8. Mix AC-130 in a polypropylene container with a 50:1 by volume mix ratio, parts A:B

9. Before applying AC-130, verify that liquids do not bead up on the surface with a couple drops of De-ionized water. Air-blast this water off.
10. Apply AC-130-2 following AC-130-2 instructions (brush on with new brush, make sure that every surface is drenched for at least 1 minute)
11. Hang up to drain for 5-6 minutes
12. Blow off excess with air
13. Allow to dry (60 min or more at room temperature, more if colder, less if warmer)
14. **DO NOT TOUCH AC-130 SURFACE AFTER DRYING!!!!**
15. Bond within 24 hours of applying AC-130 and drying OR apply Epoxy primer EW5000 AS:
 1. Datasheet: [EW5000AS](#)
16. Stir EW5000AS very well - several minutes with a stirring stick
17. Apply EW5000AS with a brush or spray. See 3M datasheet for spray tips.
18. Cure EW5000AS
 1. 30 minutes in Room Temp Air
 2. 60 Minutes at (121 +/- 3C)
19. You're done!

Surface Preparation For Carbon/Epoxy/Torlon/Ultem/High Surface Energy Plastics Surfaces:

1. Acetone Wipe
2. Abrade with 180 grit sand paper or scotchbrite
3. Acetone Wipe with Lint-Free Cloth
4. DO NOT TOUCH AFTER LAST SOLVENT WIPE
5. Bond as soon as possible. Re-cleaning is required if anyone touches the surface with their bare skin or contaminated gloves.

Bonding Instructions

1. If EW5000 AS has been applied some time ago, then lightly wipe the bonding surface with MEK. Otherwise, skip this step.
2. Apply structural epoxy
 1. 3M DP-460NS for applications where sag is important
 2. 3M DP-460 for the strongest bond
 3. 3M DP-420 for a fast work time
 4. 3M DP-105 for a flexible bond and high peel force applications
 5. Heat-cure epoxy film adhesive for surface lamination
 6. West 105 or Rhino Epoxy for non-heatable surface lamination
3. Cure under heat, preferring 3 hrs at 49C for maximum strength, not exceeding 135C

Reading Material

Papers by Kay Blohowiak are good reading on bonding stainless:

Read this paper: http://www.asetdefense.org/documents/Workshops/SURF-FIN-TempeAZ-02-08/Briefings/Blohowiak-SERDP-ESTCP_Surface_Prep_for_Adhesive_Bonding-2-08.pdf

and this one: <http://www.dtic.mil/dtic/tr/fulltext/u2/a448095.pdf>

Contact with questions about AC130:

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