3M™ Anisotropic Conductive Film (ACF) Adhesive 5363 Rework Process

General Description

This bulletin describes the method of reworking bonds made with 3M™ Anisotropic Conductive Film (ACF) Adhesive 5363. The information presented in this bulletin should be considered representative or typical. The user is responsible for evaluating the rework process under actual conditions of use and with the substrates intended for the customer application, to determine specific process parameters necessary in the individual customer's application.

Process Overview

Rework of a 3M ACF 5363 bond requires first separation of the bonded parts using heat followed by removal of most residual ACF from the bond area. This rework process is described in complete detail in the next sections. An example of the rework procedure using a 3M test vehicle is highlighted and should be used as a general guide for the necessary process required for other specific applications used by the customer. After debonding and cleaning of the residual ACF the bond area is ready for subsequent rebonding with a new section of ACF.

Required Materials/Equipment/Tools

- Protective Gloves (both for handling solvents and for protection from high temperature)
- Eye Protection
- 3M™ Novec™ 72DA Engineered Fluid or Dioxolane (Stabilized with BHT)
- Rework Station or Hot Air Gun or Hot Plate
- Forceps
- Lint-Free Clean Wipes and/or Cotton-tipped Applicators

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Safety Precautions

Rework of an ACF bond requires the use of elevated temperatures applied to parts that may be difficult to handle and solvents that may be flammable and potentially hazardous. Exercise extreme care in handling the components during the separation of the bond due to the possible exposure to high temperature and follow all manufacturers' recommendations when handling the cleaning solvents.

1. Read through and completely understand the Materials Safety Data Sheet of 3M™ Novec™ 72DA Engineered Fluid or dioxolane before use.
2. Eye protection should be worn at all times.
3. Thermally protective gloves should be worn when operating the rework station, hot air gun or hot plate when removing the flex circuit
4. Solvent protective gloves should be worn when handling the 3M™ Novec™ 72DA Engineered Fluid or dioxolane. Follow the recommendation in the MSDS for selection of the proper protective gloves.
5. Ensure that proper ventilation is in place to maintain exposure to solvent vapors below Occupational Exposure Limits. Consult the appropriate MSDS for guidance.

Process Description

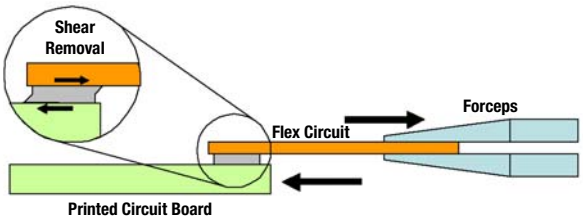
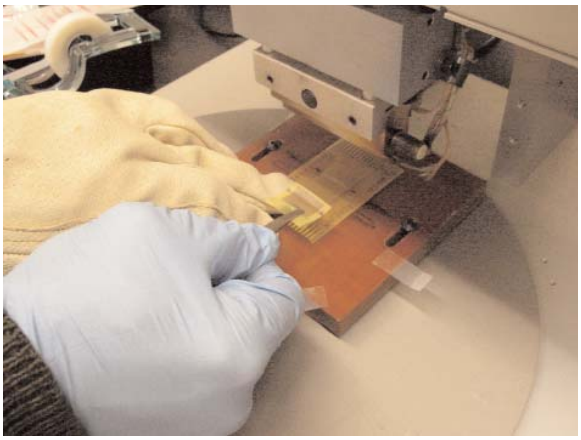
A brief description of the rework process is provided in the following Table.

Brief Summary of Rework Procedure		
Debonding	**Debonding Conditions** Temperature Time Separation Technique	 >150°C 3-5 seconds Shear along bond pads or peel away from board while hot or immediately after removal of heat source.
Solvent Soak (Optional)	**Solvent Soak Conditions** Solvent Submerge in Solvent	 3M™ Novec™ 72DA Engineered Fluid or Dioxolane 5-10 minutes

Process Description (continued)

Residual ACF Removal		
	Residual ACF Removal Conditions	
	Scrubbing Device	Cotton-tipped applicator or clean cloth (Keep wet with solvent.)
	Solvent	3M™ Novec™ 72DA Engineered Fluid or Dioxolane
	ACF Removal Technique	Keep ACF wet with solvent while rubbing pad surfaces with back-and-forth motion parallel to pads

A comprehensive description of the rework process is provided in the following sections.

Step No.	Detailed Description of Rework Process	Representative Image of Rework Process
Step 1. Debonding	**Option 1.** **Heat Debonding Using ACF Bonding Equipment** Place ACF bonded parts back into bonding station as for original bond. Adjust temperature setpoint to reach >150°C in ACF within about 3-5seconds. *(Note: Temperature setpoint may be different from original bonding conditions.)* Place shear force (lateral tension) on flex circuit while bonding thermode is compressed on bond area (such as by pulling with forceps). See Figure 1 at right. Also, it may be necessary to hold down the board to apply the shear force to the flex. See Figure 2. *(Note, for some designs, this may be a difficult operation and some alternative fixturing of the board or holding mechanism may be required to avoid difficult manual techniques.)* As the bonding thermode lifts away from the bond area the shear force will permit separation of the flex circuit from the printed circuit board. See Figure 3.	 **Figure 1. Debonding Schematic.** Schematic of shear force applied to flex circuit while applying heat to bond area.  **Figure 2. Debonding Using ACF Bonding Equipment.** Image of placement of bonded parts for debonding using the ACF bonding equipment.  **Figure 3. Debonded Flex Circuit.** Image of flex circuit following removal from printed circuit board.

Step 1. Debonding *(continued)*

Option 2.
Heat Debonding Using Hot Plate

Place ACF bonded parts on hot plate surface with temperature setpoint to reach about 150°C. *(Note: Actual temperature setpoint may need to be adjusted for ease of flex circuit removal. Modify setpoint temperature if necessary to condition that permits removal of flex circuit from printed circuit board.)*

Separate flex from board by either pulling along the pads using a shearing tension applied parallel to the bond pads (Figure 4) or peeling the flex away from the pads in a direction 90 degrees to the pads (Figures 5 and 6). *(Note: Care must be taken while separating the flex circuit if the flex circuit must be preserved to avoid damage to the pad traces.)*

Option 3.
Heat Debonding Using Heat Gun

Place ACF bonded parts on thermal insulating surface.

Apply heat by directing hot air from a heat gun over the bond area. *(Note: Actual time needed to allow for separation may depend on size of assembled parts, dimension of bond area to be debonded, and air temperature from the heat gun.)*

As the bond area heats from the directed hot air flow separate flex from board by either pulling along the pads using a shearing tension applied parallel to the bond pads (similar to Figure 4) or peeling the flex away from the pads in a direction 90 degrees to the pads (similar to Figures 5 and 6). *(Note: Care must be taken while removing the flex if the flex circuit must be preserved to avoid damage to the circuit traces.)*

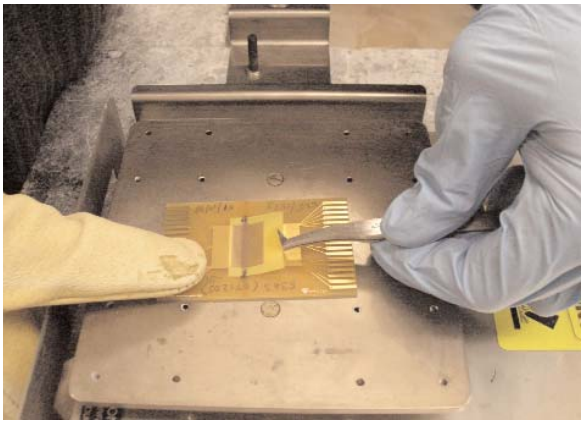


Figure 4. Debonding Using Hot Plate.
Image of set-up for debonding with printed circuit board placed on hot plate with shear force applied to flex.

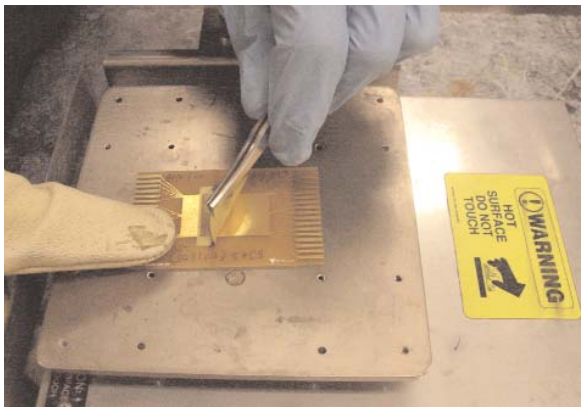


Figure 5. Debonding Using Hot Plate.
Image of set-up for debonding with printed circuit board placed on hot plate with peeling force applied to flex.

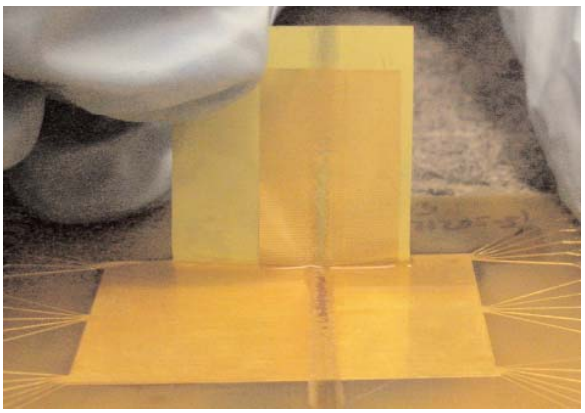


Figure 6. Debonding Using Hot Plate.
Image of debonded flex circuit with printed circuit board placed on hot plate with peeling force applied to flex.

Step 1. Debonding *(continued)*

Option 4.
Other Debonding Options

Presoaking the bond area with the ACF removal solvent (3M™ Novec™ 72DA Engineered Fluid or dioxolane) can help to soften the ACF and permit careful separation of the flex circuit from the printed circuit board by slowly peeling them apart. The solvent should be allowed to soak into the ACF for up to 5 minutes.

For some applications the flex circuit may be removed by simply peeling it free from the printed circuit board without application of heat if the flex circuit will be replaced with a new one on the subsequent ACF bond. Generally, separating without heat will lead to severe damage to the flex circuit.

Residual ACF in Bond Area

Following successful debonding of the flex circuit from the printed circuit board the ACF material will likely be present on the bond pads of both the flex circuit and the printed circuit board. An example of the residual ACF for the parts debonded using the ACF bonding equipment (as described in **Step 1. Debonding, Option 1**. above) is shown in Figures 7 and 8. The residual ACF appears as a discontinuous film across the original bond area. Some residual ACF remains on the printed circuit board (Figure 7) and on the flex circuit (Figure 8). An example of the residual ACF for the parts debonded using a hot plate (as described in **Step 1. Debonding, Option 2**, above) is shown in Figure 9.

Any residual ACF must be cleared from the bond pads to allow for a successful repeat of the ACF bond to complete the rework process. A successful ACF connection relies on the ability of the small conductive particle dispersed within the ACF film to make a reliable contact to the metal pads. Any residual, previously cured ACF material can prevent a reliable contact. The residual ACF should be cleared on the bond pad surface as a minimum requirement. For maximum reliability of the next ACF bond, most of the residual ACF between the bond pads should also be removed. However, this may require extra time and effort to effectively clear all remaining residual ACF.

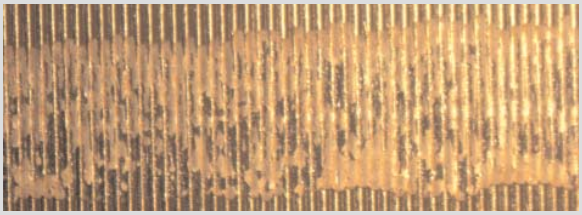


Figure 7. Residual ACF in Bond Area
Image of residual ACF on printed circuit board after debonding using ACF bonding equipment.

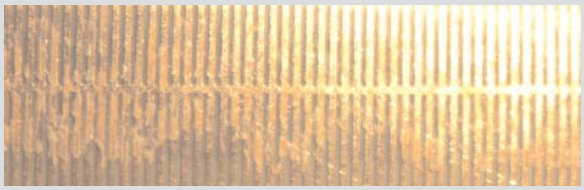


Figure 8. Residual ACF in Bond Area.
Image of residual ACF on flex circuit after debonding using ACF bonding equipment.

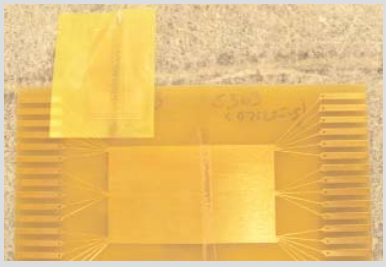


Figure 9. Residual ACF in Bond Area.
Image of residual ACF on flex circuit after debonding using hot plate.

Step 2. Solvent Soak *(Optional)*

Description of Solvent Soak Option

Complete removal of the residual ACF can be improved by submerging the bond pad in the recommended solvents. This optional soak step will have the effect of pre-softening the residual ACF to make complete removal quicker. The 3M™ Anisotropic Conductive Film Adhesive 5363 shows best results when soaked in either 3M™ Novec™ 72DA Engineered Fluid or dioxolane. The bond pads may be soaked in the solvent for 5-10 mins. *(Note, for some applications the exposure to the ACF removal solvent in areas or on components away from the bond pads may affect overall performance of the device.)* An example of a debonded printed circuit board soak is shown in Figure 10.

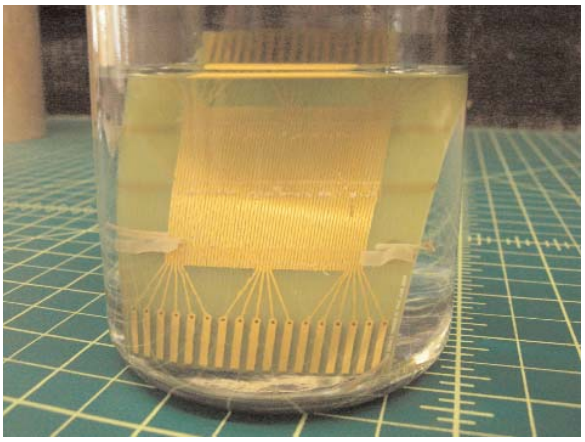


Figure 10. Solvent Soak.
Image of 3M Test Vehicle placed in container with solvent for soaking.

Step 3. Residual ACF Removal

Description of Residual ACF Removal

Final cleaning of the residual ACF requires physical scrubbing to adequately remove this from the bond pads. The physical scrubbing is best achieved using a cotton-tipped applicator or clean lint-free cloth. The physical scrubbing must be performed with the residual ACF remaining wet with the removal solvent. The recommended removal solvent is either 3M™ Novec™ 72DA Engineered Fluid or dioxolane. This may require repeated wetting of the cotton-tipped applicator or cleaning cloth with the removal solvent. The scrubbing action should be in a back-and-forth motion in the direction of the printed circuit board bond pads or flex circuit lines. Rubbing across the pads or circuit lines may lead to damage or create the potential for unsuccessful repeat bond. An example of the ACF removal technique using a cotton-tipped applicator on the printed circuit board is shown in Figure 11.

Step 3. Residual ACF Removal *(continued)*

Residual ACF Removal Process

Dip the cleaning device (a cotton-tipped applicator or clean cloth) in the removal solvent.

Quickly spread solvent across the residual ACF.

Immediately scrub repeatedly back-and-forth along the pads to loosen and remove the residual ACF. See Figure 11.

Repeat as necessary to remove any residual ACF in the bond area. *(Note: Best results on the subsequent bond with new ACF are achieved if the residual ACF is completely removed from the bond area. The time required to completely clean the bond area is related to the length of the bond area. However, a 20mm bond area has been shown to be easily cleaned after 1-2 minutes of scrubbing.)*

After most of the residual ACF has been removed from the bond area, use a dry cleaning device (a cotton-tipped applicator or clean cloth) to brush the remnants off of the printed circuit board or flex circuit.

Optionally, one final cleaning may be used with a solvent soaked cleaning device to clean the bond area of any smaller residue.

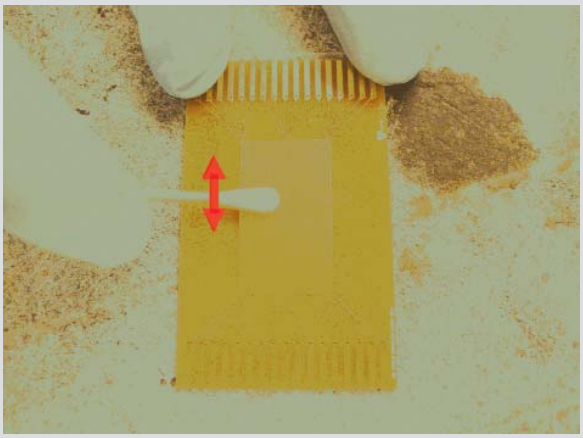


Figure 11. Residual ACF Removal
Image of 3M Test Vehicle showing removal of residual ACF by rubbing with cotton-tipped applicator soaked in solvent.

Step 4. Bond Area Inspection *(Optional)*

Example of a Clean Bond Area

A completely cleaned board is shown in Figure 12 and a higher magnification view of the bond pad area is shown in Figure 13. *(Note, the board image shown in Figures 12 and 13 were cleaned with dioxolane.)* Just to the outside of the bond pad area there is evidence for some remaining residual ACF (this is more visible in the area to the right of the pad traces in Figure 13). Between the bond pads there is little or no evidence for any remaining ACF after performing **Step 3. Residual ACF Removal.** Trace amounts of residual ACF remaining between the bond pads are not critical to the success of the subsequent bond. Also, the noticeable residue shown outside of the bond pads found in Figure 13 will not affect the performance of the subsequent bond. Any residual ACF that remains on the metal bond pads can have an effect on the success of the subsequent bond and should be retreated using the method described in **Step 3. Residual ACF Removal.**

An example of the cleaning effectiveness of the 3M™ Novec™ 72DA Engineered Fluid solution is shown in the high magnification image in Figure 14. This shows a slight trace of residual ACF both outside the bond pad area and between some of the bond pads. This level of residual ACF remaining on printed circuit board did not affect the performance of the subsequent bond (see Figure 15 below).

Bond Area Inspection Process

(Note, a 10-20X magnification optical microscope is suitable for inspection.)

Examine the bond area under an optical microscope at between 10-20X magnification.

Examine the surface of the metal pads and the space between pads. *(Note, clear metal pads are critical for a successful subsequent bond and should be free of remaining residual ACF. Excessive amounts of remaining residual ACF between the pads may have an effect on the performance of the subsequent bond.)*

If excessive residual ACF is found, further cleaning using **Step 3, Residual ACF Removal** should be completed.

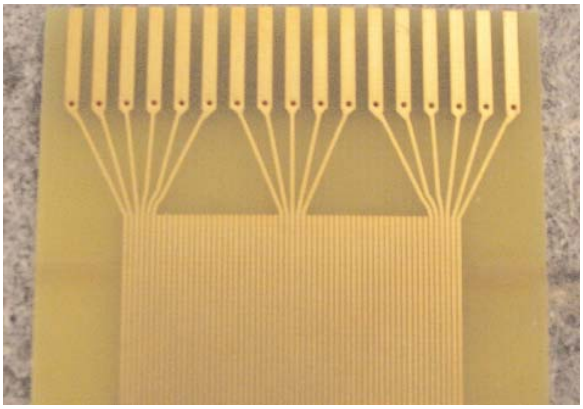


Figure 12. Bond Area Inspection.
Image of low magnification view of bond area after residual ACF removal using dioxolane.

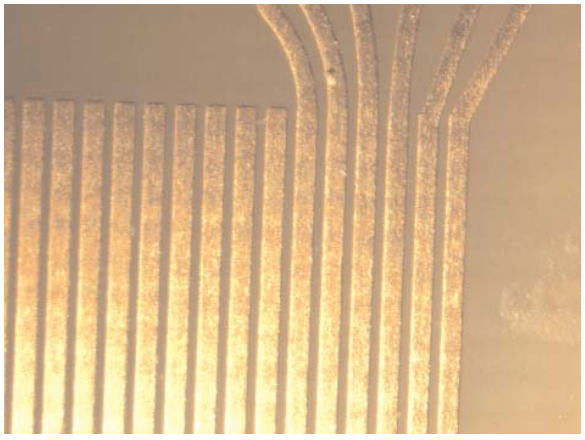


Figure 13. Bond Area Inspection.
Image from Figure 12 at higher magnification of bond area after residual ACF removal using dioxolane.

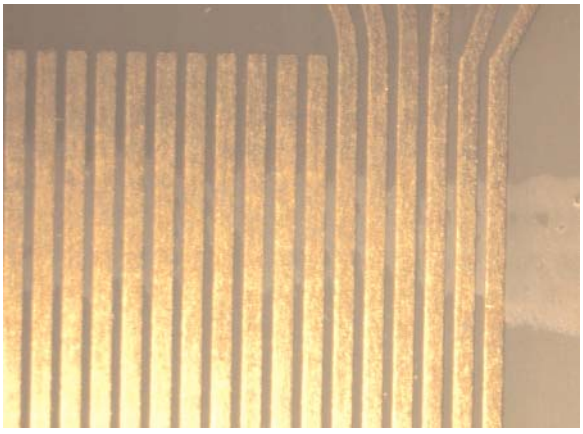


Figure 14. Bond Area Inspection.
Image of medium magnification view of bond area after residual ACF removal using 3M™ Novec™ Fluid 72DA.

Performance of Reworked Bonds

Note: The following technical information and data should be considered representative or typical only and should not be used for specification purposes.

An example of a comparison between original bond peel strength and the peel strength following rework using both recommended solvents is provided below.

Example of Typical Performance of Reworked 3M™ Anisotropic Conductive Film (ACF) Adhesive

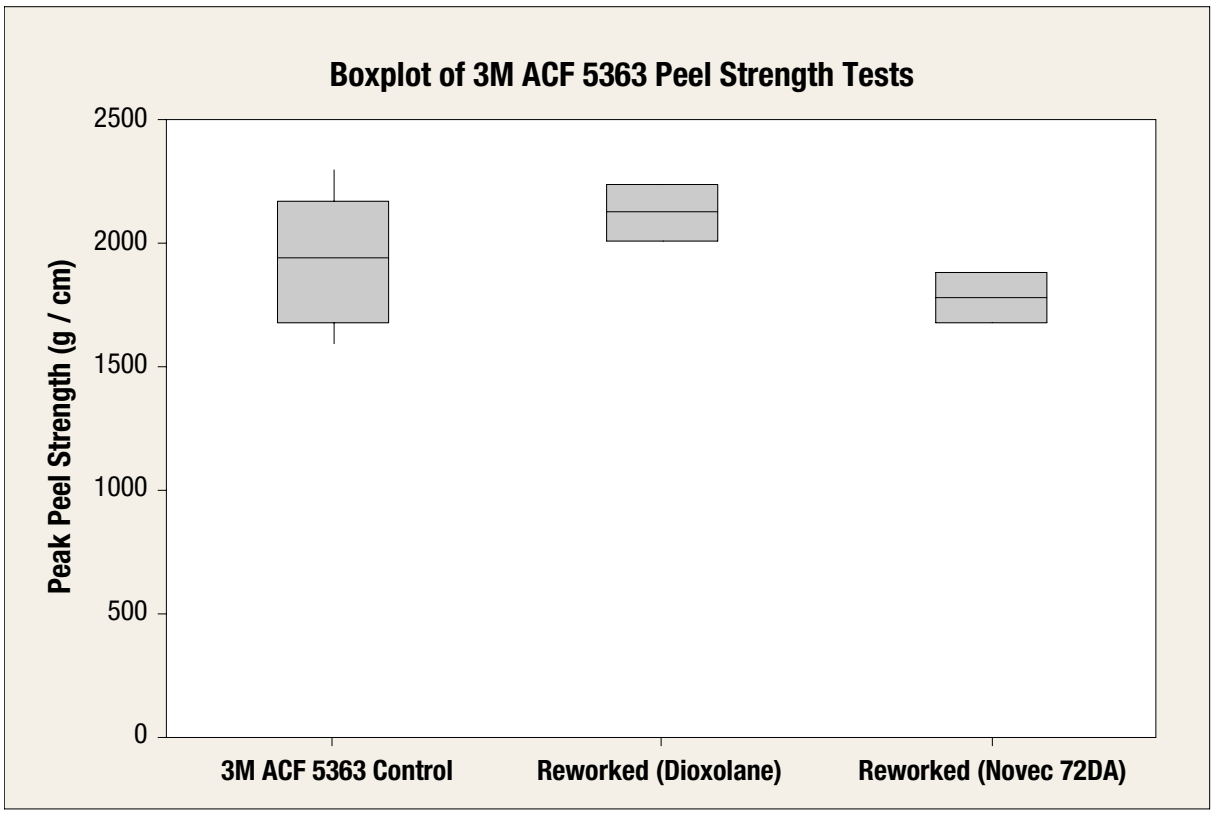


Figure 15. Graph of peak peel strength data for 3M™ Anisotropic Conductive Film 5363 control results compared to examples of reworked bond area using dioxolane and 3M™ Novec™ 72DA Engineered Fluid .

Bonds made with 3M™ Anisotropic Conductive Film (ACF) Adhesive 5363 were reworked according to the method described above. The reworked printed circuit boards were next rebonded with a new section of 3M ACF 5363. The subsequent bonds were tested for peel strength using a peel test method similar to the lot qualification test for the 3M ACF 5363 product. The results of the initial lot qualification peel strength and the peel strength measured for reworked bond test vehicles is shown in Figure 15. Both the dioxolane and 3M™ Novec™ Engineered Fluid were compared for subsequent bond performance. (Note, these actual reworked bond areas are shown in Figures 12-14.) The data indicates that the performance of the reworked bonds very closely matches the results found in the original control tests.

Precautionary Information

Refer to Product Label and Material Safety Data Sheet for Health and Safety Information before using this product. For additional health and safety information, call 1-800-364-3577 or (651) 737-6501.

For Additional Information

To request additional product information or to arrange for sales assistance, call toll free 1-800-251-8634. Address correspondence to: 3M Electronics Markets Materials Division, Building 21-1W-10, 900 Bush Avenue, St. Paul, MN 55144-1000. Our fax number is 651-778-4244 or 1-877-369-2923. In Canada, phone: 1-800-364-3577. In Puerto Rico, phone: 1-787-750-3000. In Mexico, phone: 52-70-04-00.

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