THIRTY METER TELESCOPE

M1 Polished Mirror Segment Etching and Bonding Procedure

TMT.OPT.TEC.16.001.REL04

8 Jan 2019

DOCUMENT APPROVAL

Author Release Note:
See Document Change Record for changes.
This procedure will provide guidance and process control for partner etching of the polished mirror segment and test coupons.

Prepared By:

(signature on file)

Glen Cole
TIO-TMT Lead Optical Fabrication Engineer

Concurrence:

(signature on file)

Ben Gallagher
TIO-TMT M1 Optics Lead Engineer
TIO-TMT M1 Work Package Manager

(signature on file)

Eric Hansen
TIO-TMT Optics Group Lead

DOCUMENT CHANGE RECORD

Revision	Change Approval	Release Approval	Date Released
REL04	Updated REL Release 1. Added Section 3.8 - Acid Etch Surface Protection Validation 2. Modified Sections 4.9.1 and 4.9.2 (rewrite). Modified title Section 4.9.2 (added 1.5g)	Signatures on file Docushare Routing #45970	25 Jan 2019
REL03	Updated REL Release 1. Added a cure temperature note in Section 4.3.	Signatures on file Docushare Routing #45684	7 Jan 2019
REL02	Updated REL Release 1. Added new Section 3.6 Supplemental Paste Etch Data; renumbered subsequent subsections. 2. Added content to Section 4 – Bonding Procedure WAS TBD. 3. As a result of 2, updated Section 1.6 - Abbreviations	Signatures on file Docushare Routing #43981	27 Nov 2018
REL01	Initial REL Release	Signatures on file Docushare Routing #42758	24 Oct 2018

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1 INTRODUCTION

This document provides the process details and procedures for etching Clearceram®-Z in preparation for bonding with EC-2216 epoxy.

1.2 PURPOSE

This document shall provide guidance for TMT M1 fabrication partners in creating well etched zones for effective epoxy bonds to mirror segments.

1.3 SCOPE

This procedure provides step-by-step detailed instruction for the etching Clearceram®-Z in preparation for bonding components to the polished mirror segment.

1.4 APPLICABLE DOCUMENTS

N/A

1.5 REFERENCE DOCUMENTS

RD1 Final Report on EMD2 TMT Acid Etch Process Development, (TMT.OPT.TEC.09.025)

1.6 ABBREVIATIONS

BMA	Bonded Mirror Assembly
BMAC	Bonded Mirror Assembly Component
DI	Deionized
EMD2	Engineering and Manufacturing Development, Phase 2 (M1)
FRR	Fabrication Readiness Review
M1	Primary Mirror
MEK	Methyl Ethyl Ketone
MRF	Mirror Rod Flexure
N/A	Not applicable
PMA	Polished Mirror Assembly
PPE	Personal Protective Equipment
PSA	Primary-Mirror Segment Assembly
RD	Reference Document
SSA	Segment Support Assembly
TBD	To be determined
TIO	TMT International Observatory
TMT	Thirty Meter Telescope
US	United States

2. OVERALL DESCRIPTION

Bond strength is a critically important for the Polished Mirror Assemblies. In this document, we describe the process details which, when implemented correctly, lead to low-risk, high-strength epoxy bonds. Section 3 focuses on the etching process. For specifics regarding the bonding procedure, see Section 4.

2.1 PERSPECTIVE

There are a total of 83 bonded elements for every Polished Mirror Assembly or PMA. Figure 1 details the bond locations for these Bonded Mirror Assembly Components or BMACs. All of these bonding zones need to be etched as an integral step in epoxy bonding.

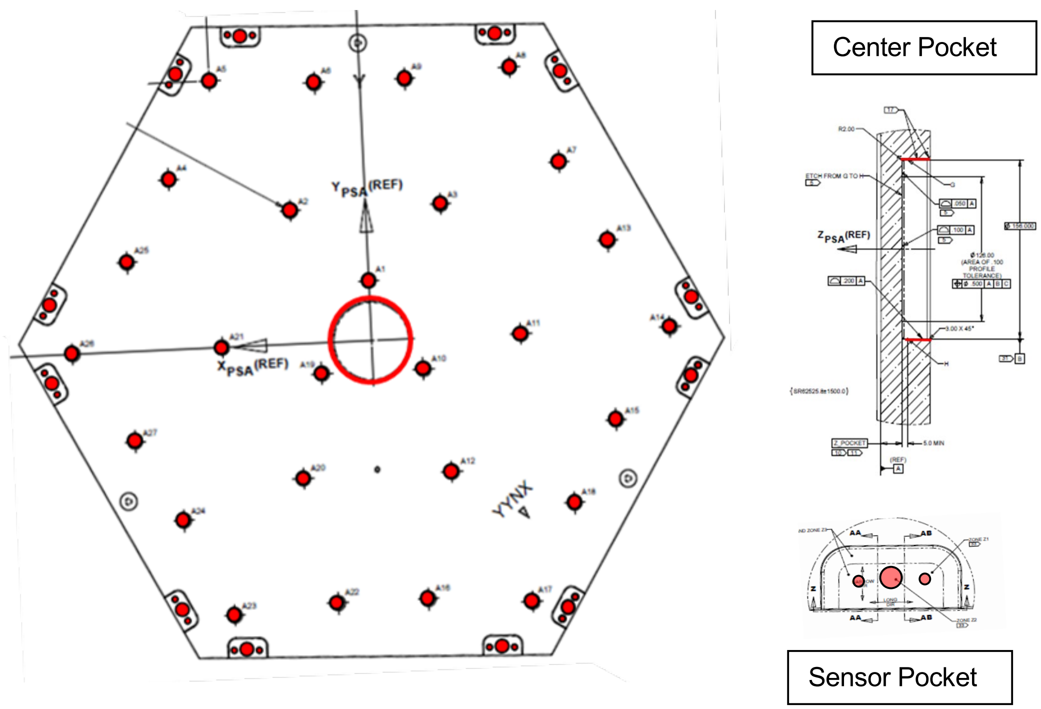


Figure 1. Bonded Mirror Assembly (BMA) Bond Locations

(27 axial, 12 sensor & 24 boot pucks + 20 diaphragm pads)

2.2 INTEGRATION

Reliably strong bonds are required to connect a polished segment with a Segment Support Assembly, or SSA. Figure 2 illustrates the integration concept.

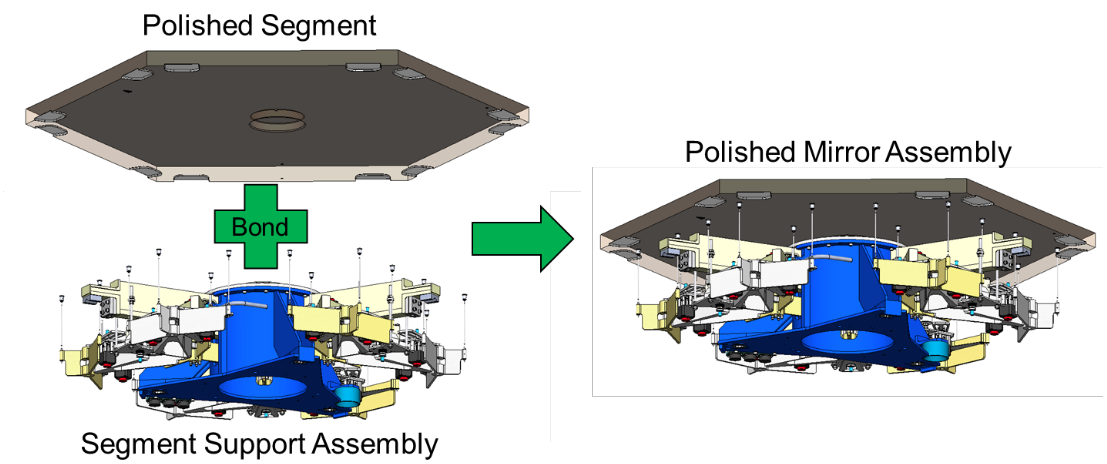


Figure 2. PMA Integration

2.3 BONDING PERSONNEL

Three international partners and one US contractor will be bonding components to polished segments in the creation of the TMT Bonded Mirror Assemblies. Each institute or entity will need guidance in the proper procedure in order to have strong and low-risk bonds. Section 4 of this document details the approved bonding procedure.

2.4 ASSUMPTIONS

The required procedures for proper etching are given in Section 3. In addition, the details specified in the procedure cannot be deviated from. If a detail of the procedure is to be deviated from, this must be approved by TMT, in advance of the FRR, and data presented to TMT in support its consideration for use.

3. ETCHING PROCEDURE

This section provides the details for the TIO approved etching procedure. There shall be no deviation from the procedure. Refinements or subtle changes need to be approved in advance by TIO and presented in the relevant Fabrication Readiness Review.

3.1 General

It is fully expected that the TMT Etching Procedure in this section will become the baseline procedure for etching, even if the partner produces their own document that contains all TIO approved variations.

3.2 Preparation

1) Establish a perimeter for the bonding activities with stanchions and caution signs. Remove trip hazards.
2) Bond technicians to use PPEs. No cell phones are allowed within the perimeter. Empty front and pants pockets and place the contents outside the segment perimeter into personal bins.

   Note: The PPEs are listed specifically for each phase but during the preparation, gather the following PPEs:

   - Eye protection
   - Nitrile gloves, nitrile apron
   - Acid Safety Kit
3) Apply etching masks to segment. Consumable etching masks can be used. The masks control the application zone of the etch paste and prevent incidental acid etching outside of the required areas.
   - Note: The axial etch masks should be a 50mm X 50mm square vinyl adhesive tape (3M type 471) with a 25 mm circular hole cut in the center and centered on the axial bond location.
4) Wash Skirts are required, in addition to the S1 protection mentioned in 5) below. This will further control the diluted etchant cream during the water rinse between paste applications (see etch sequence in Section 3.3 below). A wash skirt consists of polyethylene plastic sheeting, 150mm wide, secured to the glass periphery using 3M Type 471 Vinyl Tape.

   IMPORTANT: It is critical that no amount of the acid rinse fluid contacts any part of the glass ceramic surface. ***The water-diluted acid will destroy polished surfaces!***
5) Optical Surface Protection is a requirement. The full S1 surface shall be protected for the duration of all bonding activities. The details and validation of the effectiveness of the surface protection must be demonstrated as part of the Fabrication Readiness Review.

Consumables	Etch masks, wash skirts, Vinyl tape
Tooling	Stanchions, signs

Notes for Non-Etched Datum Surfaces:

➢ For the sensor and boot bonds within the sensor pockets, the etch zone(s) must be controlled (masked) so as not to affect (etch) the three sensor "footprints" on the bottom ground surface of the pockets. A custom etch mask is required.

➢ For the center pocket, the side, but *not the bottom*, of the pocket needs etching. The diaphragm tooling registers off of the ground bottom surface for controlling the tip/tilt and elevation of the bonded central diaphragm. The bottom of the center pocket needs to be masked. Vinyl tape can be used to mask the pocket bottom surface.

Quality Check Point	Metrics
Masking & Skirts	Mask Locations, Effective Sealing, Protection of non-etched surfaces

3.3 Etching Process (3 applications)

1) Apply a generous amount of Armour Etch paste (0.25mm to 0.5mm thick) to the etch zone using an acid brush.
   Note: ALL Armour Etch Paste bottles must be approved and controlled, the details of these requirements shall be given as part of the Fabrication Readiness Review.
2) Let the paste remain (dry) on the glass for 1 hour.

PPEs	Nitrile gloves (no powder), Nitrile apron, protective eyewear, "Acid Safety Kit"
Consumables	Etch masks, wash skirts, vinyl tape, acid brush, Armour Etch paste
Tooling	Stanchions, signs

Etching Notes:
➢ Personal Protection Equipment (PPEs) needs to be employed when using the acid paste – nitrile gloves and apron, protective eyewear and acid safety kit.
➢ Good ventilation is required.
➢ Two inch coupons are shown in this procedure, although the basic bonding preparation procedures also apply for full size segments.
➢ The glass must be etched a minimum of 25 μm deep after the three applications of the acid paste.
➢ Experimental data taken by TMT indicates that 3 @ 1 hour w/ Armour Etch on Clearceram®-Z should yield an approximately 39 μm deep etch zone (RD1).
Note: Each bottle will be tested for removal rate and then controlled, the details to be specified at the FRR.

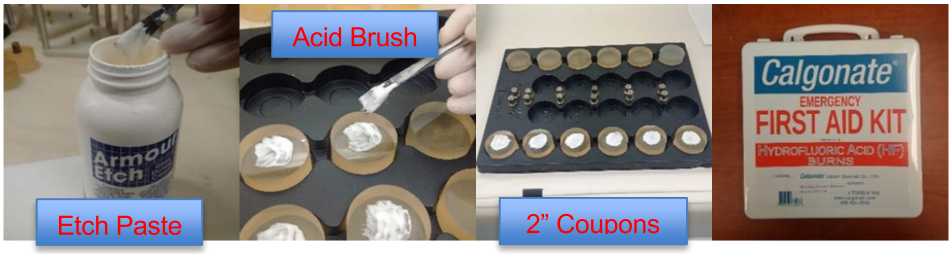


Figure 3. Acid Paste Application

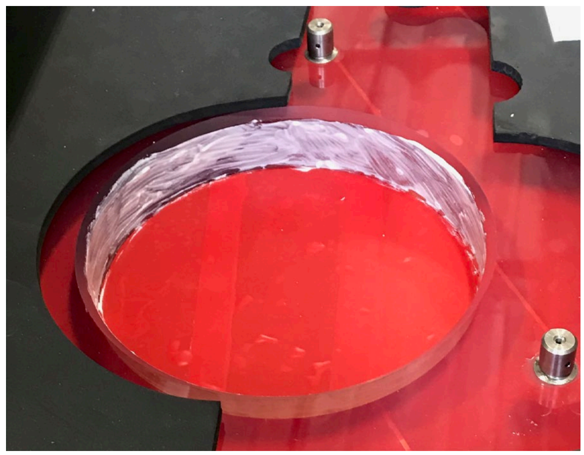


Figure 4. Etching the Center Pocket

3) Proceed to Section 3.4, for the Squeegee Step.

3.4 SQUEEGEE STEP

Note: A lot of time and energy can be saved by using a plastic or wood squeegee to remove the acid paste after 60 minutes of etching. At this time the material should able to be removed efficiently in this manner. If too much time has elapsed, the etchant cream will be hard like plaster at which point a lot of water rinsing (Section 3.5 below) will be needed as the squeegee will not be affective.

1) Use a squeegee with steady, slow and firm pressure to peel off the rubbery paste.
2) Repeat with the squeegee until ineffective.
3) Remove the paste pieces and particles with a vacuum cleaner.

Figure 5. Squeegee Removal of Acid Paste

3.5 Rinsing of Paste Residue

1) Use DI or distilled water dampened sponge to wipe and remove the acid residue.
2) Rinse the sponge out with DI or distilled water and repeat.
3) With the glass surface fully dry, inspect for residue using a small flash light.
4) Prevent water-diluted acid residue from affecting any other glass surfaces as it will destroy the polished surfaces.

   Note: It is critical that the S1 surface be completely protected from acid wash!!!

5) Rinsing and rubbing the area with a sponge or gloved hand is necessary to fully remove the dried acid paste from the glass. **DO NOT** use tap water! Tap water can contaminate the bond areas and lead to weak epoxy bond cohesion.
6) Repeat the etching and rinsing steps (Sections 3.3, 3.4 and 3.5) above an additional two times for a total of three acid etches and three DI water flushes. Let air dry in between applications.

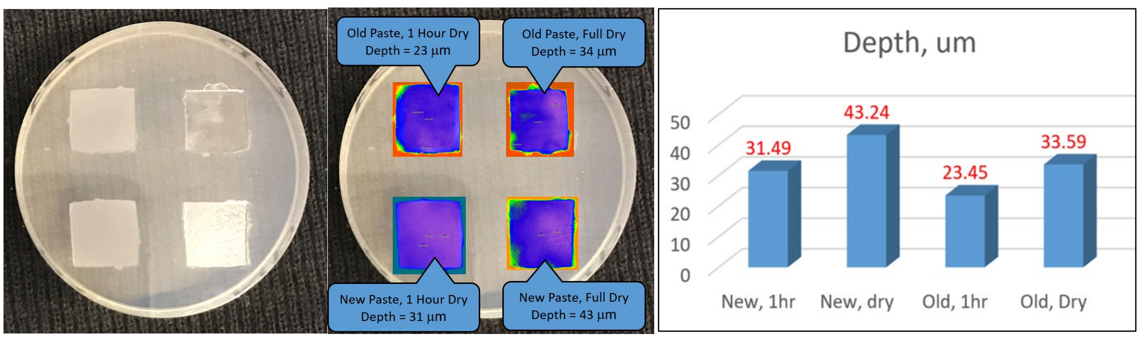
Figure 6. Rinsing Paste, Coupons

Figure 7. Rinsing Paste, Center Pocket

PPEs	Nitrile gloves and apron, protective eyewear, "Acid Safety Kit"
Consumables	Wash skirts, DI or distilled water

3.6 Supplemental Paste Etch Data

An etching paste experiment was conducted to establish the influence of the drying time and the age of the Armour Etch buffered paste on material removal of Clear Ceram-Z glass-ceramic. There were three applications of paste in masked areas and the average cumulative depth was the measured response. As can be seen by the data below, new paste etches more. Also, a longer drying time also etches more as shown. The measured etch depth represents 3 etching iterations.



3.7 Solvent Cleaning of Glass Bond Zones

Note, after the third etch and rinse, do not contaminate the etch zone with fingerprints, sweat, silicones, other oils or release agents.

1) Solvent clean the etched zones with optical wipes and reagent grade Acetone.

   Note: Solvents shall be stored long-term in glass bottles. For temporary use, smaller amounts of solvents can be stored for 1 week in a Polyethylene bottle and then must be discarded.

2) Solvent clean the etched zones with optical wipes (Kimtech Science Kimwipes, Delicate Task Wipers, 4.5" X 8.5") and Methyl Ethyl Ketone (MEK).

   a. Note: If MEK is not available, then do a second wipe with Acetone.

3) Continue to wipe with optical wipes until the etched bonding zone "squeaks" with high thumb or finger pressure (gloves required). The squeak can also be described as a "stick-slip" skittering across the surface.

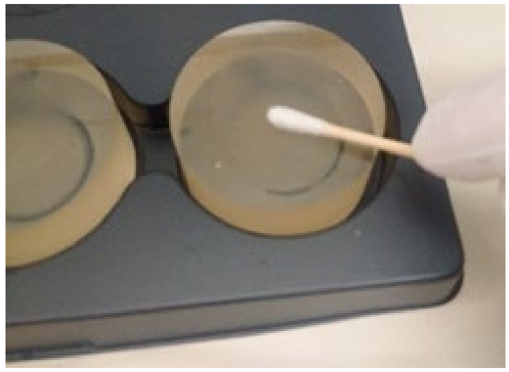


Figure 8. Solvent cleaning the etch zone

PPEs	Nitrile gloves (no powder), Nitrile apron, protective eyewear, “Acid Safety Kit”
Consumables	Cotton Swabs, KimWipes, Acetone, MEK

Note: After the etching process, the glass primer needs to be applied within 1 hour of the above solvent cleaning step. If this is impractical or there is more elapsed time than 1 hour, then the contamination protection methods must be validated. Test results for bond strength are needed as part of the FRR to validate the etch protection details.

3.8 Acid Etch Surface Protection Validation

Note: This section applies only if the etching of the bond zones is performed in advance (greater than 1 week) of the bonding activities for the Bonded Mirror Assembly. The purpose is to ensure that the surface protection applied to the etched zones is adequate for cohesive bond strength.

1. Etch the bond zones on the segment and bond zones for three (3) coupons (polished ClearCeram Z HS) per the above Etching Procedure, Sections 3.1 through 3.7.
2. Apply the protective layer on all etch zones for both the segment and the coupons.
3. Keep the coupons and the segments stored together until just before segment bonding (1 week maximum).
4. Remove surface protection from coupons.
5. Solvent clean per Section 3.7 above.
6. Bond axial pucks (Invar with BR127 primer) to coupons per bonding procedure below, Sections 4.1 through 4.8.
7. Allow coupons to cure for 7 days at room temperature (20ºC), then pull coupons in tension to failure and record.
8. If all of the strengths are greater than 2100 psi at 20ºC, then the etch protection is validated. Note: 2100 psi represents the minimum tensile strength in the lab.
9. If any of the three strengths are less than 2100 psi, then inspect for cohesive failure and re-etch the bond zones prior to production bonding of the Bonded Mirror Assembly.

10. Note that the Etch Protection coupons described here are in addition to the Production Witness Coupons specified in Section 4.9.2.

4. BONDING PROCEDURE

4.1 Solvent Cleaning of Invar Bond Zones

1. Wipe with optical wipes (Kimwipes, Delicate Task Wipers, 4.5” X 8.5”) and Acetone.
2. Wipe with optical wipes and isopropyl alcohol (70%).
3. Let dry 10 minutes. Note: the isopropyl alcohol will absorb water in the air and can stay wet for a minute or so.

PPEs	Nitrile gloves (no powder), Nitrile apron, protective eyewear, “Acid Safety Kit”
Consumables	Cotton swabs, Optical Wipes, Acetone, Isopropyl Alcohol

4.2 Glass Priming

1. Use **only** Large Alpha Swabs, TX714A, made by TexWipe to apply the primer.
2. Dip the swab directly into the primer (Lord AP-134, expiration is within 1 year of manufacturing).
3. Let the excess primer drip back into the container. Wait 3 seconds between drips.
4. Wipe (scrape) the excess primer on the edge of the bottle lip, wipe 2 times on each side of Alpha swab.
5. Apply the primer in a single side-to-side flat stroke across the surface and cover the bond area with a minimum of overlap between strokes.

Note 1: This approach has been developed to yield the correct manufacturer-recommended primer thickness of between 1.5 and 2.5 microns. Thicker depositions of primer will significantly reduce the strength of the epoxy bonds, especially in the case where the loads are in the lateral or shear direction.

Note 2: The BR-127 is an adhesive primer which enhances the bond strength by preventing hydrolysis of the metallic oxide layers and minimizing additional oxide build up. This maximizes the cohesive strength of the adhesive bonds to the invar. Properly prepared and protected BR-127 surfaces have an indefinite shelf-life.

6. <u>Let the primer dry</u> at room temperature for between <u>two and twenty-four hours.</u>

   <u>*IMPORTANT PRIMER NOTES*</u>:

   - The primer needs at least 2 hours to fully hydrolyze. Bonding will be compromised if this time period is not adhered to. For short prime time of 10 minutes, the strength is reduced 13%.
   - The primer should be kept clean and bonding initiated before 24 hours has passed since the primer application. The primer can be compromised and contaminated if this time period is not respected. For long prime times of 4 days, the strength is reduced 11%.

- Use ONLY “Lord AP-134” Silane primer. No other primers are qualified for this application.
- After the primer has been exposed to the moist room air, the primer begins to hydrolyze and can be degraded in performance. For this reason, it is recommended that attention is paid to the 1 year expiration date. If the primer begins to turn gelatinous, discard it.

PPEs	Nitrile gloves (no powder), Nitrile apron, protective eyewear, “Acid Safety Kit”
Consumables	Large Alpha Swabs (TX714A), Lord AP-134 Silane Primer

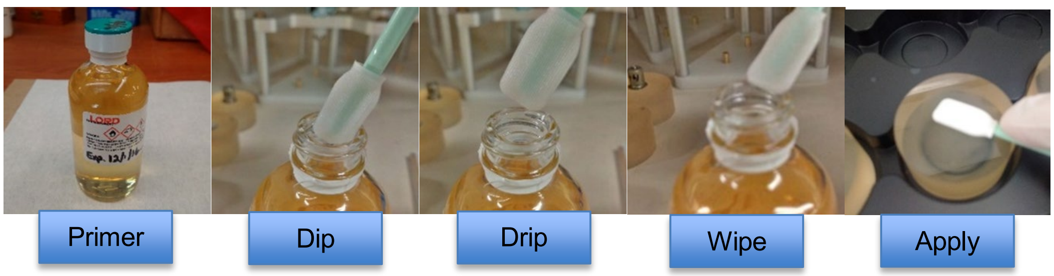


Figure 9. Primer Sequence

Quality Check Point	Metrics
Primer Check	Proper application of Silane primer

4.3 Epoxy Mixing

1. The glass has been prepared and primed as described earlier in this procedure.
2. The invar pucks and or tabs have certified BR-127 primer applied to the surfaces and were solvent-cleaned just prior to epoxy mixing.

PPEs	Nitrile gloves (no powder), Nitrile apron, protective eyewear, “Acid Safety Kit”
Consumables	6” Mixing nozzles, 3M 2216 Epoxy (43 ml tubes)
Tooling	3M 08190 Epoxy Gun

3. Assemble the 2216 Epoxy dispenser.

Figure 10. Epoxy Dispenser Assembly

4. Remove the air from 2216 cartridge and get epoxy components flowing properly.

   Note: Perform this ***prior*** to connecting the mixing nozzle to the dispenser.

   Note 1: It is common for one component to start flowing first. Shortly after, the second component will begin flowing. Once both are flowing freely, only then, connect the 6 inch mixing nozzle. Shorter nozzles are not sufficient to guarantee good mixing.

   Note 2: The recommended mixing and curing temperature is between 20C and 25C.

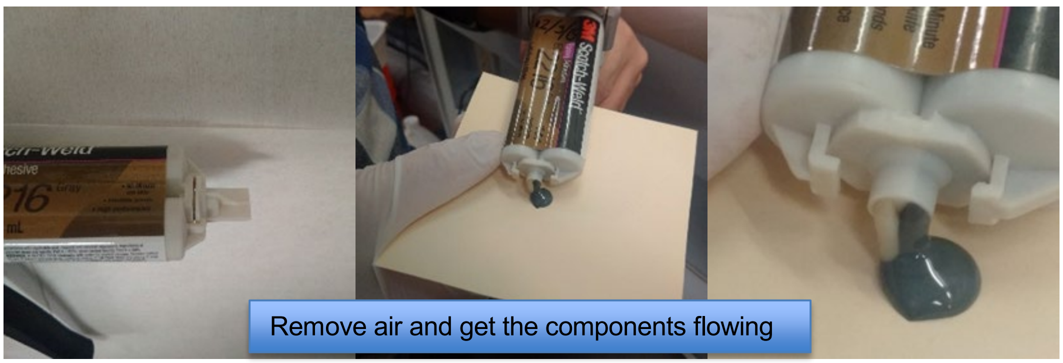


Figure 11. Removing Air from the Epoxy Cartridge

5. Connect the mixing nozzle to the dispensing gun. Slowly squeeze the dispenser grip, mixing the A & B epoxy components within the nozzle.
6. Dispense the epoxy upon the MRF pucks or optionally directly on the glass, depending on the bonding tooling.

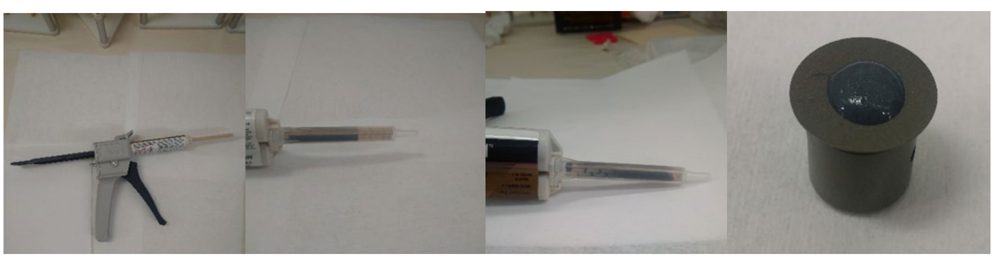


Figure 12. Mixing and Dispensing the Epoxy

Quality Check Point	Metrics
Epoxy Mixing	Proper mixing of Epoxy

4.4 Bond Thickness

Establish the epoxy bond line thickness as follows:

1. Mix the 2216 epoxy with 0.25mm glass (Borosilicate) microspheres. The proper amount is 0.5% by weight, which is, for instance, 16 balls for and axial puck, is the minimum to establish the bond line thickness.

   Note: The use of microspheres is the approved approach to establish the bond thickness. Other fixturing approaches which make use of 0.25mm shims or monofilament fishing line can be evaluated as part of the Fabrication Readiness Review. Also, if there are too few microspheres, there is a risk of crushing them with the fixture compression. If there are too many microspheres, then the reduced adhesive volume will have reduced strength.

2. The bond line thickness for the Central Diaphragm pads is established with the integral O-rings and the bonding fixture and no microspheres are to be used.

Figure 13. Using Microspheres to Establish the Bond Line Thickness

Quality Check Point	Metrics
Microspheres	Proper use of microspheres

4.5 Bond Tooling – Axial and Sensor Pucks

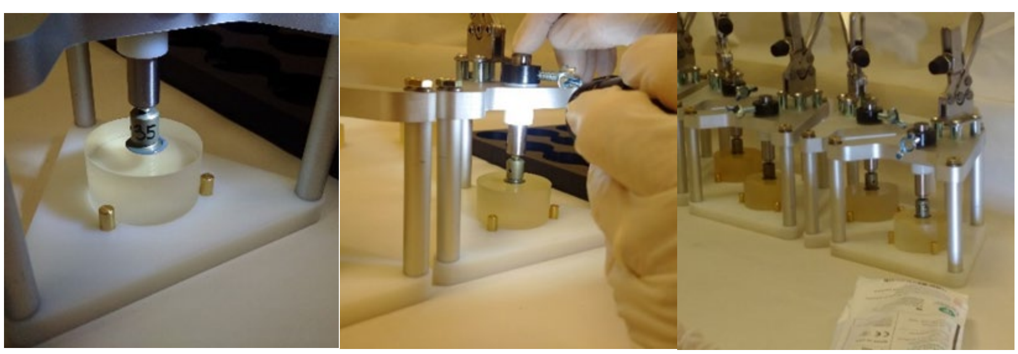


Figure 14. Bond Fixturing for Axial Bond Coupons

Figure 15. Bond Fixturing for Full-Size Segment

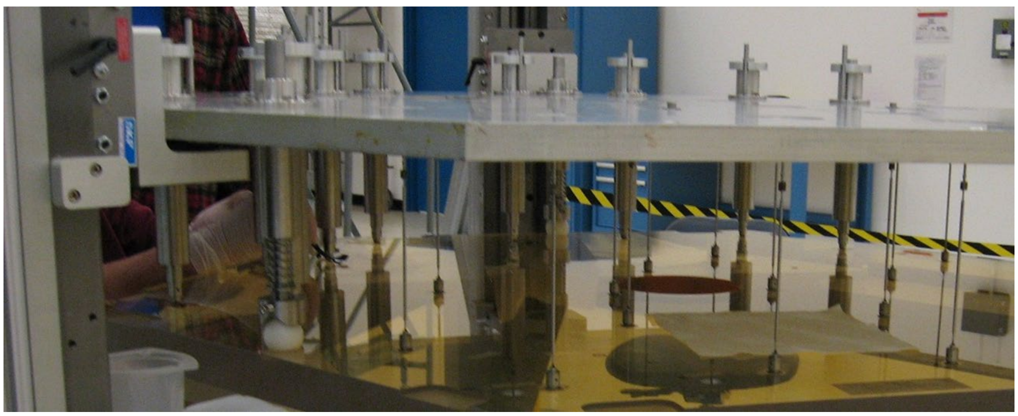


Figure 16. Bond Fixturing for the creation of a Bonded Mirror Assembly

4.6 Bond Tooling – Central Diaphragm

4.6.1 Populate the 20 pads with the Viton O-Rings

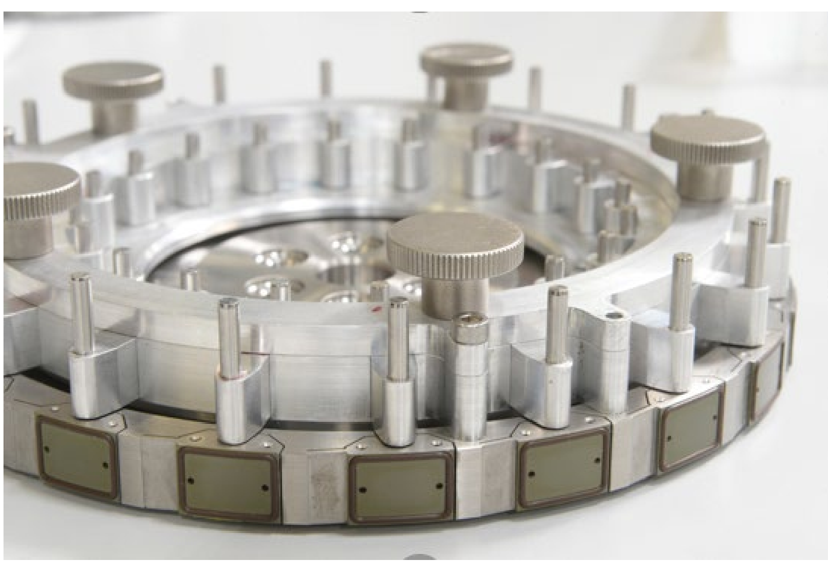


Figure 17. Bond Fixturing with Central Diaphragm showing the O-rings in place

Using gloved hands, press the Viton O-Rings into each of the 20 grooved flexure pads. With practice, this can be accomplished in a few minutes but initially a technique needs to be developed. Starting at one corner and working away in both directions simultaneously has shown promise. Try not to twist the O-ring during installation as it will tend to roll out of the groove or tend to be unstable. Note: The center pocket has already been etched and primed.

4.6.2 Place the shim ring against the O-rings

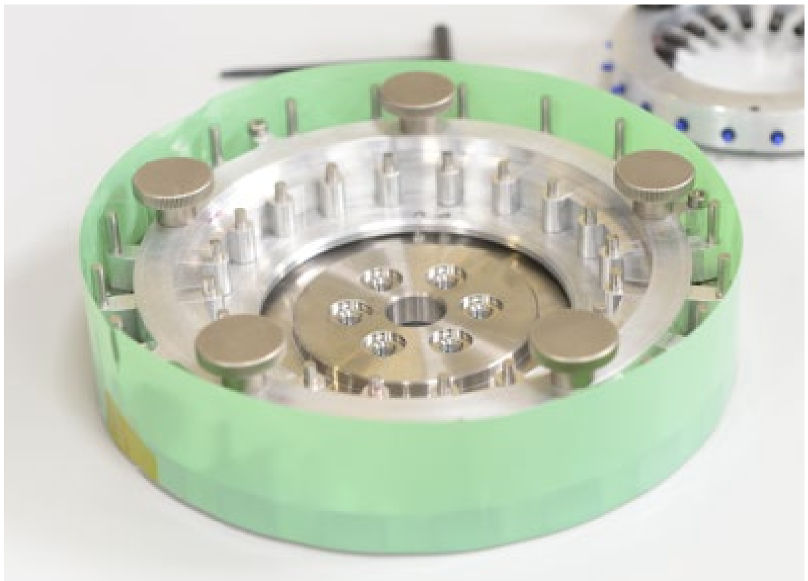


Figure 18. Shim Ring in place

Cut a strip of 0.005” plastic shim stock and wrap around the O-ring-populated diaphragm with minimal overlap and secure with Kapton tape. This will assist in the placement of the diaphragm into the center pocket, without losing any O-rings due to scrubbing friction. Pay attention to the clocking, although this will be refined with fixturing in subsequent steps.

4.6.3 Carefully remove the shim ring

Figure 19. Shim Ring removal

Using gloves hands, remove the shim ring by pulling on the exposed edge and working around the periphery a few times.

4.6.4 Place diaphragm in correct Tip-Tilt and Depth

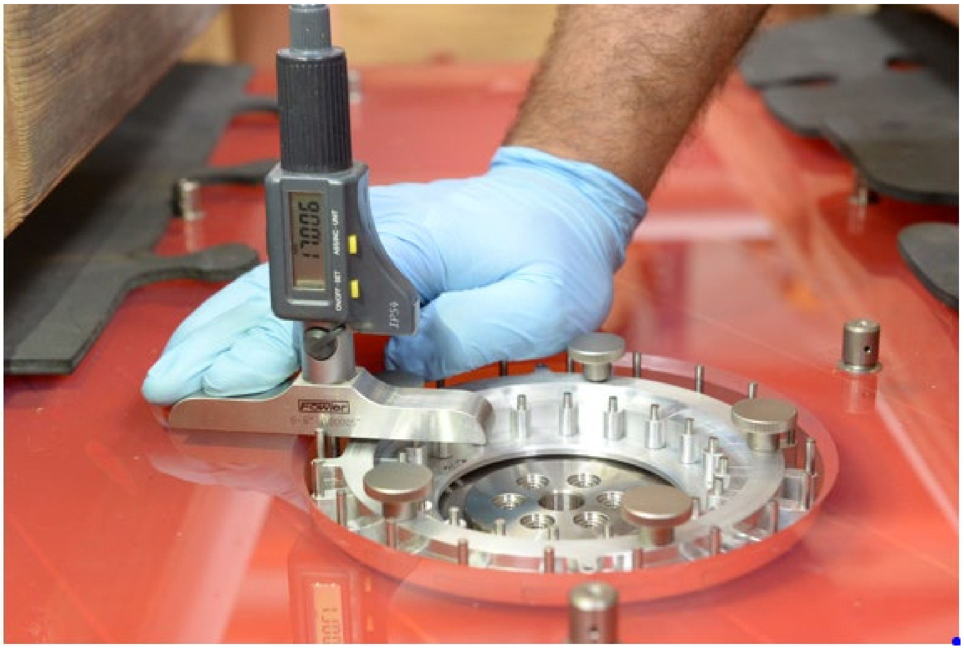


Figure 20. Using Depth Mike to Position Diaphragm

Adjust the tip, tilt and depth of the diaphragm to the drawing-specified numbers. The adjustment is accomplished by turning the three nylon-tipped set screws.

4.6.5 Align Diaphragm using the fixture

Figure 21. Diaphragm Alignment Fixture

The clocking of the diaphragm is important. Here, the fixture shown engages with the diaphragm features and aligns to a datum cone in the S2 surface. After proper placement, install the inner spring-plunger ring and apply radial compression to each pad. Careful viewing through the polished S2 surface should be an initial indication of the O-ring seal. If sealed, you will observe a black rounded rectangular O-ring compression lines.

4.6.6 Pressure check each of the 20 O-ring pads

Figure 22. Seal check of the pads

It is important to pressure check each O-ring-sealed epoxy volumes before we commit to epoxy injection of the flexure pads. If there is a leak, you need to resolve the problem. If for instance, one of the O-rings was slightly out of position, there would not be a good seal on that particular pad.

4.6.7 Mix the 2216 epoxy and deliver to a syringe

Figure 23. Filling Syringe with epoxy

The 2216 epoxy dispenser is connected to a 150mm long mixing tube and delivered, as shown, to a syringe. Be careful to always have an air channel at the top of the syringe. Do not entrap air.

4.6.8 Removing Air from Syringe

Figure 24. Removing air from syringe

Install the plunger in the syringe and angle as show to put the air pocket towards the end as the plunger and expel the air from the epoxy syringe. Put the 1mm needle on the end and prepare for epoxy injection.

4.6.9 Dispensing Epoxy

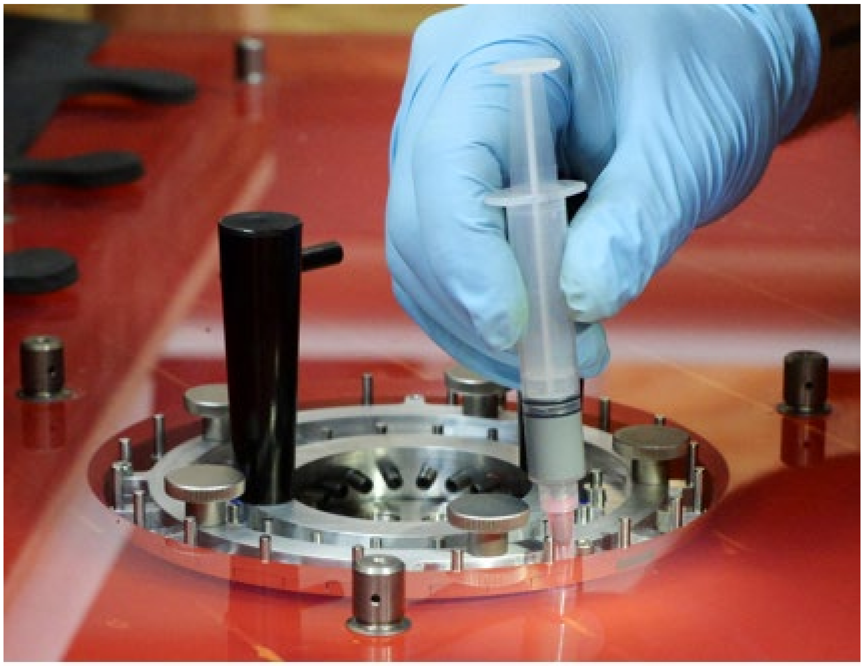


Figure 25. Dispensing epoxy

Place the needle on one of the two epoxy ports. Maintain a normal incidence to reduce epoxy leakage on the input side. Slowly inject the epoxy until the exit port lets a small drop of adhesive out of the top of the pad surface. The epoxy volume can be seen as a gray rectangle when viewed through the S2 surface as shown.

4.6.10 Bonded Diaphragm

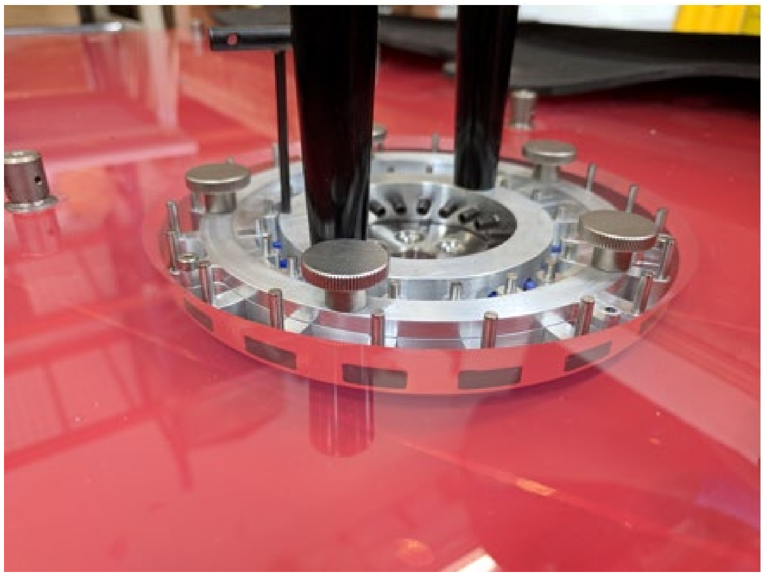


Figure 26. Diaphragm bonding complete

The completed and bonded central diaphragm should be fixtured for 1 to 3 days before the fixturing is removed. After 2 days or longer, the SSA can be integrated with the bonded mirror assembly.

4.7 Epoxy Clean Up (Axial, Sensor and Boot Pucks)

1. Clean up the extra epoxy as shown using dry cotton swabs.
2. Use dry cotton swab and rotate the swab so that the extra epoxy is carried to the top of the swab, away from the glass.
3. Then, discard that swab and continue, in this fashion, with a new swab, until the extra epoxy has been removed from the periphery of the axial puck.
4. It is important to remove the epoxy otherwise this will add local stresses to the glass which can initiate slow crack growth. “Unsupported epoxy” should not be present on any bonds!
5. DO NOT use ANY solvents with the swabs as this may affect the epoxy bond cross-linking and adhesive strength.
6. The epoxy should remain in the fixture for 1 day at room temperature (20C), prior to any movement or adjustment of the bonded elements.

Quality Check Point	Metrics
Epoxy Clean Up	Make sure epoxy is properly cleaned up

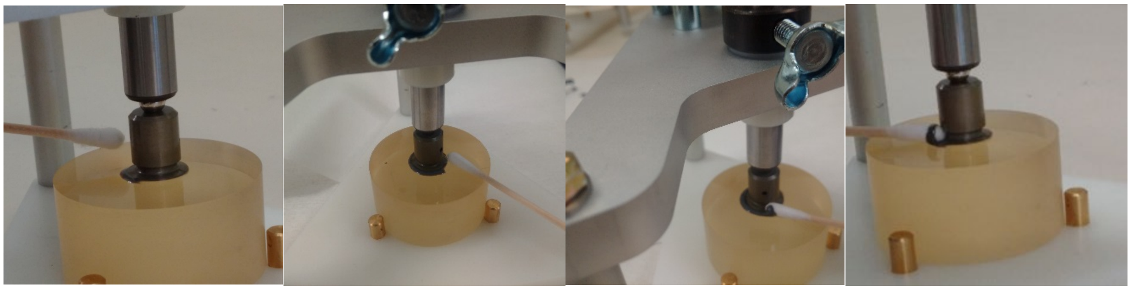


Figure 27. Epoxy Bond Clean Up

4.8 Bond Curing

Curing Notes:

- The bonded joints will be at 90% strength after 7 days at room temperature.
- Normally, the bonded components are not disturbed for 24 hours. After that, the fixturing can be removed.
- After 72 hours, loads can be applied, which means the assembly of the SSA could commence.
- Accelerated aging can reduce the cure time significantly. One hour at 100C will accelerate the cure and, in addition, increase the adhesive strengths by 25% to about 3200 psi. ANY warm curing needs to be approved by the TIO Project Office.

4.9 Coupons and Workmanship Pulls

4.9.1 Witness Coupons: Pulled to Failure during Production SSA Integration

Three tensile witness coupons are pulled to failure for every newly completed Bonded Mirror Assembly. The resulting strength data is recorded in the data package for that blank / segment. If the failure tensile stress is below 2200 psi when pulled at 20ºC, then the bond should be considered non-conforming. If the strength is greater than 2200 psi at 20ºC, then record the pull strengths in the data package for the PMA and continue with integration into a Bonded Mirror Assembly.

4.9.2 Witness Coupons Pulled to 150% (1.5g) After Production Integration

TMT plans to keep operational coupons associated with each segment under load at the observatory to provide early warning of potential bond degradation. These coupons should come from individual epoxy pots or “early” and “late” if using a mixing cartridge gun. There will be from 2 to 4 coupons per segment, the details to be defined as part of the associated FRR.

The coupons and the tensile pucks shall be defined by TMT. Provisionally, the Clear Ceram coupons are 25mm in diameter and 15mm thick, polished both sides. The BR127 primed Invar pucks are TBD, but will be bonded on both sides of the glass pucks.

4.9.3 Proof Load Applied to Bonded Components

Table 1. Bonded Component Proof Loads

	Bonded Component	Area (in^2)	Proof Load (lbs.)
1	Axial Puck	0.239	181
2	Diaphragm Pad	0.166	126
3	Sensor Puck	0.099	75
4	Boot Puck	0.099	75
5	Fall Safety Pad	0.161	122

Note 1: The tensile proof strength is 759 psi. This is about 30% of the expected room temperature tensile bond strength. The proof load rationale is that it represents a load, when applied to bonded components, would catch process problems before this leads to “cohesive” failures. The cohesive strength for an oxide bond is 759 psi, for instance, and represents the lower bound of our process-varied bond strengths.

Note 2: The proof loads applied to the bonded components in Table 1 are in tension, even though the operational loads are in both tension and shear. The practical reason is that the tensile loads are more easily implemented with fixturing and will still reveal process-related issues for both tensile and shear load cases.

If any component becomes detached after the proof load is applied, then the component needs to be replaced with a new component, following the approved bonded-component replacement procedure, (RD1).