LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Preparation of an end or input test mass (ETM/ITM) (Hydroxide-Catalysis Bonding of ears)

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1 Introduction

1.1 Purpose and Scope

This document defines the procedure for preparing an ETM/ITM test mass (D080658-v3 and D080657-v3) for installation into the quadruple suspension structure. The procedure consists of hydroxide catalysis bonding on a fused silica 'ear' (suspension element according to D080751-v1) to each of the surfaces S3 and S4 in a well-defined location and re-storing the mass. General hydroxide-catalysis bonding procedures are detailed in E050228. The procedure assumes the mirror substrate has been fully prepared with HR and AR coatings applied to respectively the front and the back surface of the substrate. It includes mirror handling with the ergo-arm during these procedures. Mirror handling procedures with the ergo-arm are detailed in T1000082.

It assumes that the mass has been stored in a COC ETM storage container or 'cake-tin' (D0902146). Both coated surfaces have First Contact films already applied to them. The procedure starts from the point of removing the mass from the 'cake-tin' using the ergo arm. It finishes with the 4-week curing period needed to cure the ears. The test mass is stored back into the cake-tin container during this curing period.

The procedure does not include cleaning and/or baking procedure prior to inserting the mass into the structure. On the date this update was written this was not considered as part of the procedure for the silica masses.

The document starts with giving an overview of the required lab-settings and tooling followed by giving the relevant documentation.

It then discusses the detailed steps of the procedure including location, timing, number of personnel needed and tooling needed.

1.2 Low detail time schedule

	Day 1	Day 2	4 Weeks	People required
Unpack mass and measure width				Yes
Bond ear 1				Yes
Bond ear 2				Yes
Curing				No

1.3 Required lab-settings

The surfaces must be free of particles, thus, the bonding must take place under a Class 100 laminar flow bench or in a Class 100 clean-room.

Operator must be dressed in clean room attire: overall, boots, head cover, facemask, and approved cleanroom gloves are required.

This clean-room has a sink with running DI water with a resistance of 18 MOhm. It also has two tables of normal height (between 70 and 75 cm).

1.4 Equipment and Materials

- Filtered dry nitrogen
- Air gun or unplugged (De-)Ionizing gun (de-ionizing gun must be unplugged for at least 5 minutes prior to use near flammable liquid)
- High intensity light source (ideally handheld battery supported)
- DI water 18 MΩ resistance
- Pipettor with tip ejector - variable volume, 2-20 µl, Eppendorf 2000 - (VWR Cat. No. 53511-588)
- Microcentrifuge tubes - Eppendorf, 1.5 ml - (VWR Cat. No. 20901-551)
- VWR® MiniFuge Microcentrifuge - 120V, 50/60Hz - (VWR Cat. No. 93000-196)
- Microcentrifuge tubes storing rack - (VWR Catalog No. 20901-675)
- Centrifuge tubes - polypropylene, graduated, 15 ml – (VWR Cat. No. 21008-103)
- Centrifuge tube's rack – (VWR cat. No. 21008-485)
- Medical Filter: Whatman Filter Uniprep 0.2UM PK50 UN113ENYL Filter
- Eppendorf* epTIPS* Pipette Tips – Sterile PCR Clean Filter Tips, 2-20 µl, 10 Racks of 96 Tips – (VWR Cat. No. 47745-092)
- Alpha 10 wipes - case – (VWR Cat. No. TWTX1010)
- Gloves - VWR Certi-Clean Class 100 Latex Gloves or Accu Tech Ultra Clean 91300 Gloves.
- Methanol – Spectroscopic grade
- Acetone – Spectroscopic grade
- Sodium bicarbonate (= Bicarbonate of soda)
- Cerium oxide polishing compound
- Micro 90® detergent (International Products Corporation)
- Sodium Silicate Solution – from Sigma-Aldrich 338443-1L (~10.6% NaOH, ~26.5% SiO_2 by weight)
- Ultrasonic cleaner - BRANSON 8510
- 2x V-block - D1001685
- Bonding jig - D1001592
- Metric slip gauges
- Allen key for #2-56 socket-head cap screw
- Digital calipers – with metric setting

- UHV aluminium foil
- Glass petridishes
- Magnifying glass
- First contact
- Ergo-arm

1.5 References

Design documentation 'glass' essentials	
D080657	ALIGO COC ITM SUBSTRATE
D080658	ALIGO COC ETM SUBSTRATE
D080751	ETM ITM quad production ear
D0902455	ETM bonded assembly
D0902456	ITM bonded assembly
Design documentation of the alignment jigs	
D0901592	ASSEMBLY DRAWING – NP-type bonding jig
D0901591	Baseplate – NP-type bonding jig
D1000128	Penultimate mass prism holder
Measurement reports on 'glass' essentials	
Q10xxyy	Relevant test mass control measurements
Q10xxxx	Relevant ear control measurements of ears
Back ground documents	
E050228	(Specification) Silicate Bonding Procedure
T0900402	Enhanced LIGO core optic drag wipe cleaning procedure
E0900394	aLIGO Optic Container Shipping Procedure
E1000079	Advanced LIGO First Contact procedure for large optics
T1000114	ALIGO NP-type: - Report on Ear Bonding at LASTI 27th August – 31st August
T0900447	Ear fabrication readiness review
M080134	ETM/ITM and BS/FM pitch frequencies and d-values
T1000534	Ergo-arm users manual
T1100238	Report on hydroxide catalysis bonding done at LHO in March and April 2011
D0902146	ASSEMBLY, ETM, COC OPTIC CONTAINER, ADVANCED LIGO
D1100555	Metrology baseplate for ear and prism position measurements

E1000079	First Contact Application and Removal Procedure
F1000006	Bond quality monitoring form
E1000265	Jig-settings calculation sheet

1.6 Version history

04/08/10: Requested DCC number for the document.

08/04/10: Release v1 onto DCC.

18/02/2011: Release v2 onto DCC.

31/03/11: Release v3 onto DCC – added a small overview schedule at the start of the document

02/08/11: Release v4 onto DCC – added procedural steps to measure the width of the mass at the bonding jig location, added procedural steps to check the position of the ears and prisms on the mass, a flag to slant the mass slightly to prevent the ear from drifting away from the jig

31/08/11: Release v5 onto DCC – correction of equation in step 43.