SPIRE BSM Declared Processes

Procedure ID SPI-BSM-PRJ-708 ITEM 18

Thermal stabilisation

Author :	Ian Pain
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VERSION CONTROL

Date	Index	Remarks
12/06/01	1.0	New Issue
20/03/02	1.1	Added more detail to AOCC ref in RD table
17/06/04	1.2	Updated version numbers and reformatted document to same as other processes

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Applicable documents

Applicable documents are project specific and may be assumed to apply fully to the BSM, unless stated otherwise

Ref	Title	Author	Reference	Date
AD 1	SPIRE BSM Declared Process List v 1.6	IP	SPI-BSM-PRJ-0708	15/06/04
AD 2	SPIRE ATC PA PLAN v1.5	BCG	SPI-BSM-PRJ-0711	15/07/02
AD 3				
AD 4				

Reference documents

Reference documents are generic and may only apply in part to the project, or may be for information or reference only.

Ref	Title	Author	Reference	Date
RD 1	Heat Treatment of Aluminium Alloys		MIL-H-6088	
RD 2	Engineering specification of the Applied Optics Centre Corp. "Procedure for Heat Treating 6061 type aluminium alloy for optimum stability"		AOCC-0600S dated 1/18/72	
RD 3	Federal specification of forged Aluminium alloys		QQ-A-367	
RD 4	Procedure for the thermal cycling of cryogenic Aluminium Alloy 6061 to obtain optimum dimensional stability at Cryogenic Temperatures		UK ATC (Michelle Project) 00d010M	
RD5				

Glossary

Refer to: http://www.roe.ac.uk/atc/projects/spire/SPIRE_BSM_Glossary.html

1 SCOPE

This document defines the thermal cycling process to be used to provide dimensional stability for all type 6061 aluminium alloy precision components used at 80K or below. Normally this process is only applied to optical components and associated piece parts.

2 INTRODUCTION

The Beam Steering Mirror (BSM) is a small flat mirror which may be steered in two axes. It is being designed and built at the UK Astronomy Technology Centre and will be subsequently integrated into the Spectral and Photometric Imaging REceiver (SPIRE) instrument as one of three instruments on the Herschel Space Observatory.

The Herschel Space Observatory (formerly the Far Infra-Red and Sub-millimetre Telescope), is the fourth cornerstone mission in European Space Agency's 'Horizon 2000' programme, and with a 3.5m primary mirror it will be the biggest space telescope yet flown. Herschel will provide the astronomical community with a powerful multi-purpose observatory capable of observations in the relatively un-explored 50-700mm wavelength range.

The SPIRE optics are intended to allow full optical alignment on the ground, as well as transmission of the science signal.

3 REQUIREMENTS

To properly stabilise a material for low temperature use, it is desirable to cool the piece below its lowest operating temperature. In Michelle the optical elements operate at below 25 K. However since most of the thermal contraction occurs between ambient and 77 K it is acceptable to thermally cycle using liquid Nitrogen.

3.1 Material

This process is to be used for items made from forged (QQ-A-367) Aluminium Alloy 6061 provided in the T6 or T651 conditions i.e. the material should have been solution heat treated and artificially aged in accordance with MIL-H-6088. Alternative materials may only be used with the prior approval of the project mechanical authority.

3.2 Equipment required

- An Air Furnace capable of operation up to a minimum of 500 K (225 deg C) with temperature control to better than ± 5 K.
- 2 off insulated cryogenic flasks with 300mm min. inside diameter, 150mm min. in height.
- supports to suspend the work pieces in the cryogenic flask
- frames to support the work pieces during air cooling (may be same as above)
- cryogenic temperature sensing equipment

4 OVERALL PROCEDURE

A record sheet as shown in Appendix 1 is to be kept for each item and returned with the item to the SPIRE BSM Product Assurance Manager at the UK ATC upon completion.

4.1 Rough machine blank to within 0.4mm-0.8mm of final dimensions where tolerances are ±0.13mm or less. Where larger tolerances are specified, machine to within final tolerance. Do not drill or tap any holes at this stage.

4.2 Place roughed blank in the air furnace at a temperature of 450 K ±5 K. Allow temperature to stabilise and leave for a further six hours. Remove blank from the furnace and allow to air cool to room temperature.

4.3 Thermal cycle blank five times as per section 4.

4.4 Finish machine the blank to bring all sizes within tolerance. Drill and tap all holes.

4.5 Repeat steps 4.2 and 4.3.

4.6 Finish machine high precision surfaces by Diamond machining or other methods.

5 THERMAL CYCLE

5.1 Suspend the blank 50-100mm above the surface of the cryogen and allow to cool within 30K, ±3 K of the cryogen temperature (~105 K). The largest surface area of the blank should be facing the liquid surface. When the above temperature is attained slowly lower the blank into the cryogen so that at least one-third of the item is completely submerged.

5.2 Leave the item in the cryogen for five minutes after rapid boiling has ceased. Remove from the cryogen and allow to warm in air to the ambient temperature, 295 K, ±5 K.

5.3 Place in an air furnace with the temperature set to 365 K, ±5 K. Leave in the furnace until the item has attained the furnace temperature throughout (~3-4 hours) .

5.4 Remove from the furnace and allow to air cool to ambient.

5.5 Repeat steps 4.1 to 4.4 for the number of times specified.

6 APPENDIX 1.

The attached sheet is to be completed for all SPIRE BSM piece parts requiring cryogenic thermal cycling for dimensional stability. Completed sheets are to be returned to the SPIRE BSM Product Assurance Manager at the UK ATC

RECORD OF THERMAL CYCLING

Part Name	Drawing No.	Issue	Serial No.

SUPPLIER: _____

Operation	Completed	Date	Name
Initial Machining			
Stabilise 6hrs at 450 K			
Cycle 1: 77 K and 365 K			
Cycle 2: 77 K and 365 K			
Cycle 3: 77 K and 365 K			
Cycle 4: 77 K and 365 K			
Cycle 5: 77 K and 365 K			
Final Machine, drill and tap			
Stabilise 6hrs at 450 K			
Cycle 1: 77 K and 365 K			
Cycle 2: 77 K and 365 K			
Cycle 3: 77 K and 365 K			
Cycle 4: 77 K and 365 K			
Cycle 5: 77 K and 365 K			
Diamond Machine			

Upon completion return form to:
Brenda Graham, BSM Product Assurance Manager
UK ATC, Blackford Hill, Edinburgh EH9 3HJ