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**LIGO Certification Report**

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This Certification Package relates to the following substrate: **Input Test Mass (4 km)**

**Serial number: 4ITM05C**

The Package consists of the following documents:

**1. Printed documents**

HABA - LIGO - C - PD:	Certification of Physical Dimensions and Registration Mark location, orientation and dimensions
HABA - LIGO - C - SB:	Certification of Side and Bevel Polish
HABA - LIGO - C - SP:	Certification of Scratches and Point Defects
HABA - LIGO - C - SN:	Certification of Serial Number location, dimensions
HABA - LIGO - C - SF:	Certification of Surface Figure for Sides 1 and 2
HABA - LIGO - C - SL:	Certification of Surface Errors - Low Frequency, for Sides 1 and 2
HABA - LIGO - C - SH:	Certification of Surface Errors - High Frequency, for Sides 1 and 2
Attachment 1	Hard copy print out of LADI data for Side 1 with piston, tilt removed and also for piston, tilt, power, astigmatism removed
Attachment 2	Hard copy print out of LADI data for Side 2 with piston, tilt, removed and also for piston, tilt, power, astigmatism removed
Attachment 2A	Hard copy print out of LADI data for transmitted wave front in measurement configuration where beam enters through side 2, reflects from side 1 and exits through side 2, with piston, tilt removed and also for piston, tilt, power, astigmatism removed
Attachment 3	Hard copy printouts of TOPO 2D data obtained with 2.5X and 40X heads at three central positions (side 1)
Attachment 4	Hard copy printouts of TOPO 2D data obtained with 2.5X and 40X heads at three central positions (side 2)

**2. Electronic data**

Surface maps for sides 1 and 2 are available at the CSIRO ftp site under the following file names:

LADI data:	4ITM5C1.zip (Side 1)	4ITM5C2.zip (Side 2) 4ITM5CT.zip (wave front)
TOPO data: (2.5X)	T24IM51A.asc (Side 1)	T24IM52A.asc (Side 2)
	T24IM51B.asc	T24IM52B.asc
	T24IM51C.asc	T24IM52B.asc
(40X)	T44IM51A.asc	T44IM52A.asc
	T44IM51B.asc	T44IM52B.asc
	T44IM51C.asc	T44IM52C.asc

1	<b>Substrate Type:</b>	4ITM
2	<b>Serial Number:</b>	4ITM05
3	<b>Physical quantity certified:</b>	<b>Physical Dimensions and Registration Mark</b>
4	<b>LIGO specification reference:</b>	D960803-B-D
5	<b>CSIRO measurement/inspection procedure reference:</b>	HABA-LIGO-M-PD
6	<b>Variations to the measurement/inspection procedure:</b> (indicate Yes/No and attach separate sheet if Yes)	No
7	<b>CSIRO Log Book Reference</b>	LN00028 p 30
8	<b>Team member responsible for measurement/inspection:</b>	C Sona
9	<b>Measurement/inspection results reviewed by:</b>	C Walsh

## 10. Results

[Measurement errors ( $\pm 1\sigma$ ) shown only where they are comparable to tolerances specified or when measurement is within  $2\sigma$  of boundary of acceptability]

Physical Quantity	Result
Diameter	250.97 mm
Cylindricity	0.01 mm
Thickness (maximum - for FM, RM, ETM) (minimum - for BS)	100.005 mm (NB: 0.005 mm above top tolerance for this dimension)
Bevel as per drawing (height, angle):	(S1) Height:2.21 mm Angle:45 <sup>0</sup> 11' (S2) Height:2.23 mm Angle:44 <sup>0</sup> 51'
Wedge angle:	1 <sup>0</sup> 12'
Location of registration mark ( $\pm$ angle with respect to minimum part thickness):	+2'
Location of other 3 marks (with respect to registration mark at minimum thickness)	90 <sup>0</sup> 00', 180 <sup>0</sup> 00', 270 <sup>0</sup> 01'
Registration mark dimensions (OK/ not OK)	OK

**11. Certification**

The measurements and inspection data presented in this report were obtained using the procedures outlined in the relevant CSIRO procedures document (sec. 5). These results have been reviewed against the LIGO specifications (sec. 4). Taking into account the variations (if any) from these measurement procedures noted in sec.6, CSIRO certifies the substrate to comply with the LIGO specification for this physical quantity.

Project Manager:

  
10 Dec 98

Chris Walsh

Date:

LIGO Certification Report    Side and Bevel Polish

1	<b>Substrate Type:</b>	4ITM
2	<b>Serial Number:</b>	4ITM05
3	<b>Physical quantity certified:</b>	Side and Bevel Polish
4	<b>LIGO specification reference:</b>	E960093-C-D
5	<b>CSIRO measurement/inspection procedure reference:</b>	HABA-LIGO-M-SB-A
6	<b>Variations to the measurement/inspection procedure:</b> (indicate Yes/No and attach separate sheet if Yes)	No
7	<b>CSIRO Log Book Reference</b>	LN00062
8	<b>Team member responsible for measurement/inspection:</b>	E Pavlovic
9	<b>Measurement/inspection results reviewed by:</b>	J Seckold

**10. Results**

Defects, if any, in the side and bevel polish compared to the LIGO specification (4 above) are detailed below (*team member to note defects here; if none seen, note "no defects observed"*).

**No defects observed**

**11. Certification**

The measurements and inspection data presented in this report were obtained using the procedures outlined in the relevant CSIRO procedures document (sec. 5). These results have been reviewed against the LIGO specifications (sec. 4). Taking into account the variations (if any) from these measurement procedures noted in sec.6, CSIRO certifies the substrate to comply with the LIGO specification for this physical quantity.

Project Manager:



Chris Walsh

Date:

10 Dec 98

1	<b>Substrate Type:</b>	4ITM
2	<b>Serial Number:</b>	4ITM05
3	<b>Physical quantity certified:</b>	Serial Number and location
4	<b>LIGO specification reference:</b>	E960093-C-D
5	<b>CSIRO measurement/inspection procedure reference:</b>	HABA-LIGO-M-SN-A
6	<b>Variations to the measurement/inspection procedure:</b> (indicate Yes/No and attach separate sheet if Yes)	No
7	<b>CSIRO Log Book Reference</b>	LN00062
8	<b>Team member responsible for measurement/inspection:</b>	E Pavlovic
9	<b>Measurement/inspection results reviewed by:</b>	J Seckold

### 10. Results

Quantity inspected	Result of Inspection (OK / not OK)
Location of serial number as per drawing (sec. 4)	OK
Orientation of serial number as per drawing (sec. 4)	OK
Height of lettering	OK

### 11. Certification

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Project Manager:

Date:

*Chris Walsh*  
10 Dec 98

Chris Walsh

1	<b>Substrate Type:</b>	4ITM
2	<b>Serial Number:</b>	4ITM05
3	<b>Physical quantity certified:</b>	Scratches and Point Defects
4	<b>LIGO specification reference:</b>	E960093-C-D
5	<b>CSIRO measurement/inspection procedure reference:</b>	HABA-LIGO-M-SP-A
6	<b>Variations to the measurement/inspection procedure:</b> (indicate Yes/No and attach separate sheet if Yes)	No
7	<b>CSIRO Log Book Reference</b>	LN00062
8	<b>Team member responsible for measurement/inspection:</b>	E Pavlovic
9	<b>Measurement/inspection results reviewed by:</b>	J Seckold

### 10. Results

	Numbers of point defects		Total Area of scratches (square micrometres)	
	Inside central 80 mm	Entire surface (235 mm)	Inside central 80 mm	Outside central 80 mm (235 mm)
Surface 1	nil	nil	<5,000	< 5,000
Surface 2	nil	nil	< 5,000	<5,000

### 11. Certification

The measurements and inspection data presented in this report were obtained using the procedures outlined in the relevant CSIRO procedures document (sec. 5). These results have been reviewed against the LIGO specifications (sec. 4). Taking into account the variations (if any) from these measurement procedures noted in sec.6, CSIRO certifies the substrate to comply with the LIGO specification for this physical quantity.

Project Manager:



Chris Walsh

Date:

10 Dec 98

↑ Thin

2000

4ITM05

SIDE 1

2000 S1

2000

2000 S1

2000





LITMOS - SIDE 2

~~0001~~

~~0002~~

1000

4000

1	Substrate Type:	4ITM
2	Serial Number:	4ITM05
3	Physical quantity certified:	Surface Figure
4	LIGO specification reference:	E960093-C-D
5	CSIRO measurement/inspection procedure reference:	HABA-LIGO-M-SF-A
6	Variations to the measurement/inspection procedure: (indicate Yes/No and attach separate sheet if Yes)	No. Data files for transmitted wavefront represent two passes
7	CSIRO Log Book Reference	LLN/0137-02
8	Team member responsible for measurement/inspection:	E Pavlovic
9	Measurement/inspection results reviewed by:	B Oreb

## 10. Results

	Radius of Curvature in km	Astigmatism (nm)	Electronic data file reference
Surface 1	13.28	4.2	4ITM5C1.zip
Surface 2	13.46	3.3	4ITM5C2.zip
Wavefront*	-5.07		4ITM5T.zip

\* Measured as per the test procedure in E960093-C-D.

Hardcopies of the phase maps are attached to this certification as part of Attachment 1 for Side 1 and Attachment 2 for Side 2. Phase map data is stored in electronic format at the CSIRO ftp site under the filenames shown in the third column.

## 11. Certification

The measurements and inspection data presented in this report were obtained using the procedures outlined in the relevant CSIRO procedures document (sec. 5). These results have been reviewed against the LIGO specifications (sec. 4). Taking into account the variations (if any) from these measurement procedures noted in sec.6, CSIRO certifies the substrate to comply with the LIGO specification for this physical quantity.

Project Manager:



Chris Walsh

Date:

10 Dec 98

LIGO Certification Report    Surface Errors - Low

1	<b>Substrate Type:</b>	4ITM
2	<b>Serial Number:</b>	4ITM05
3	<b>Physical quantity certified:</b>	Surface Errors - Low Spatial Frequency
4	<b>LIGO specification reference:</b>	E960093-C-D
5	<b>CSIRO measurement/inspection procedure reference:</b>	HABA-LIGO-M-SL-A
6	<b>Variations to the measurement/inspection procedure:</b> (indicate Yes/No and attach separate sheet if Yes)	No
7	<b>CSIRO Log Book Reference</b>	LLN/0137-02
8	<b>Team member responsible for measurement/inspection:</b>	E Pavlovic
9	<b>Measurement/inspection results reviewed by:</b>	B Oreb

**10. Results**

	Low Frequency Surface Errors (nm)	
	80 mm aperture	200 mm aperture
Surface 1	0.6	0.8
Surface 2	0.6	1.3

Hardcopies of the phase maps over the central 200 mm with piston, tilt, power and astigmatism removed are attached to this certification in Attachment 2 for Side 1 and Attachment 2 for Side 2.

**11. Certification**

The measurements and inspection data presented in this report were obtained using the procedures outlined in the relevant CSIRO procedures document (sec. 5). These results have been reviewed against the LIGO specifications (sec. 4). Taking into account the variations (if any) from these measurement procedures noted in sec.6, CSIRO certifies the substrate to comply with the LIGO specification for this physical quantity.

Project Manager:

*Chris Walsh*  
10 Dec 98

Chris Walsh

Date:

1	<b>Substrate Type:</b>	4ITM
2	<b>Serial Number:</b>	4ITM05
3	<b>Physical quantity certified:</b>	Surface Errors - high spatial frequency
4	<b>LIGO specification reference:</b>	E960093-C-D
5	<b>CSIRO measurement/inspection procedure reference:</b>	HABA-LIGO-M-SH-A
6	<b>Variations to the measurement/inspection procedure:</b> (indicate Yes/No and attach separate sheet if Yes)	No
7	<b>CSIRO Log Book Reference</b>	LLN/091
8	<b>Team member responsible for measurement/inspection:</b>	F Lesha
9	<b>Measurement/inspection results reviewed by:</b>	C Walsh

**10. Results**

*10.1 Surface errors in nanometres averaged over sampling locations within central 80 mm:*

**Side 1:            0.19 nm**

**Side 2:            0.18 nm**

*10.2 Surface errors in nanometres averaged over all sampling locations on surface:*

**Side 1:            0.19 nm**

**Side 2:            0.19 nm**

*10.3 Surface errors in nanometres at different positions A through H on surface:*

	A	B	C	D	E	F	G	H
<b>Surface 1</b>	0.20	0.17	0.18	0.18	0.19	0.19	0.19	0.20
<b>Surface 2</b>	0.19	0.18	0.18	0.18	0.17	0.20	0.19	0.20

Two - dimensional surface maps at three central locations are available at the CSIRO ftp site under filenames of the form TMXX0YZA.asc, where M is the objective used (M=2 for 2.5X, 4 for 40X), XX is the substrate type, 0Y is the number, Z = 1 or 2 is the side and A = A, B, C, ... is the sampling position. Hard copies of the data are at Attachment 3 (Side 1) and Attachment 4 (Side 2).

### 11. Certification

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Project Manager:

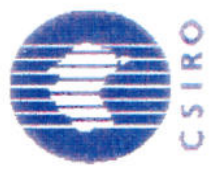


Chris Walsh

Date:

10 Dec 98

# LADI CERTIFICATION DATA



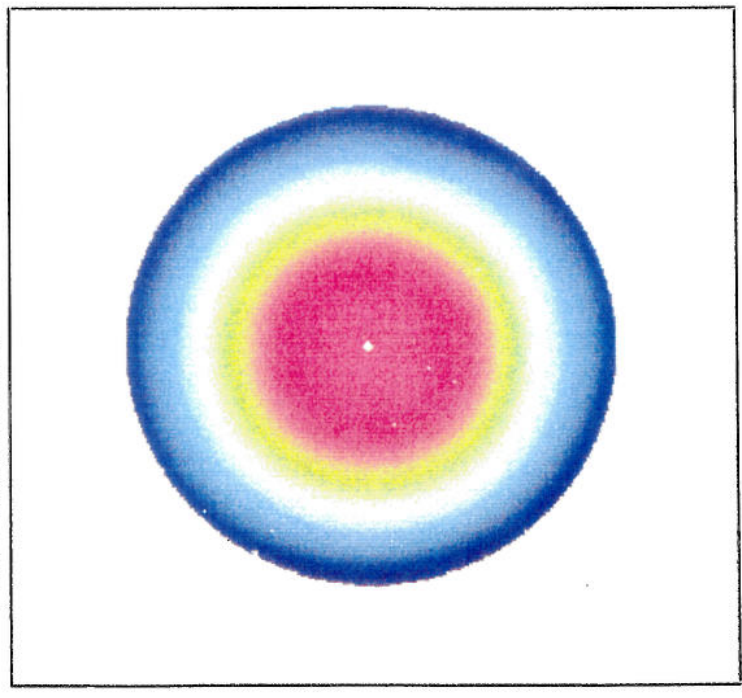
Title: 4ITM05T

Date: 12/04/98 Astig: -44.6 nm

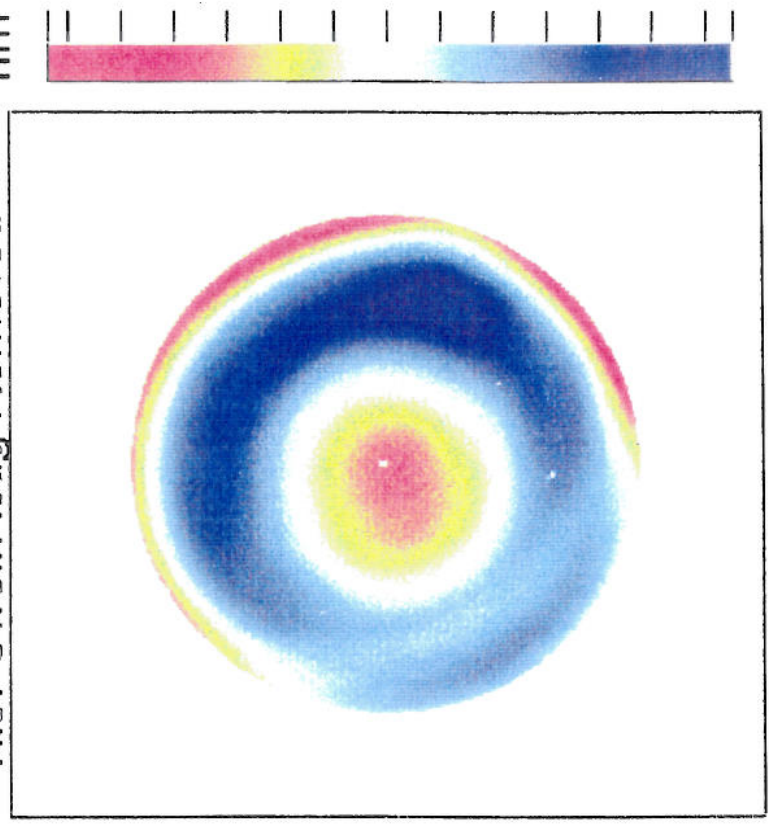
Diameter: 200 mm Power: -988.8 nm

PV: 128.8 nm  
RMS: 22.3 nm

Tilt Removed



Tilt/Power/Astig Removed



# LADI CERTIFICATION DATA

Title: 4ITM052

Date: 11/25/98

Diameter: 200 mm

Astig: 3.3 nm

Power: 372.0 nm

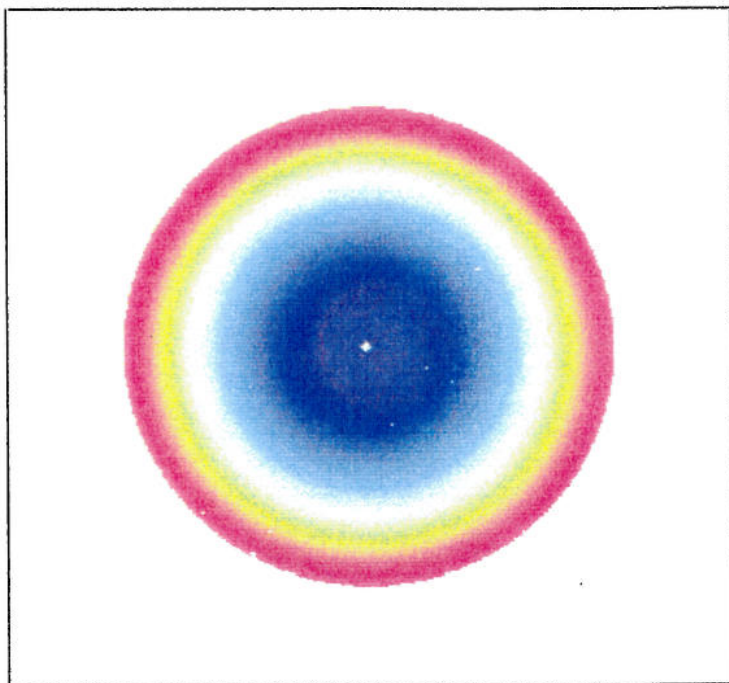


CSIRO

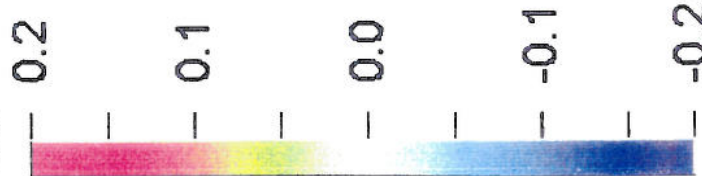
PV: 9.1 nm

RMS: 1.3 nm

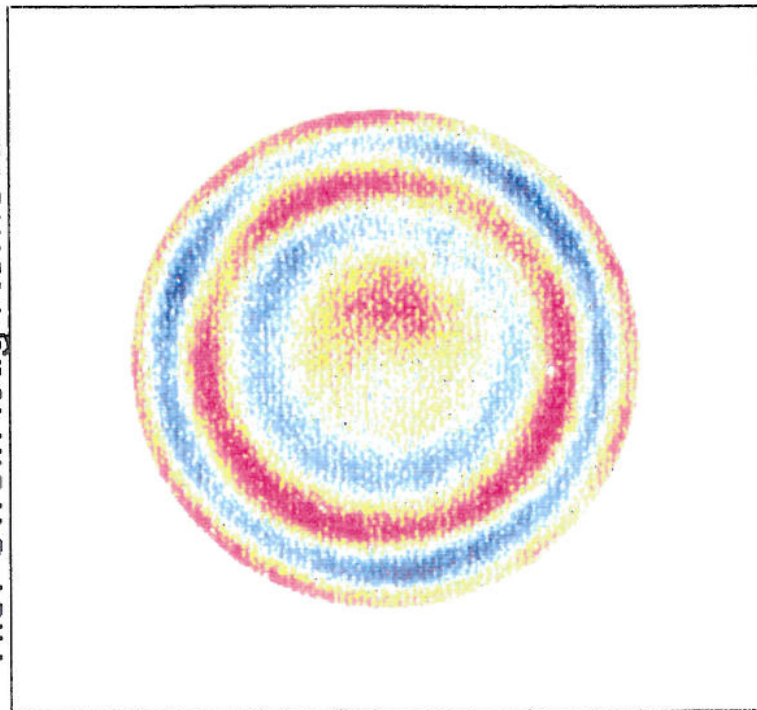
Tilt Removed



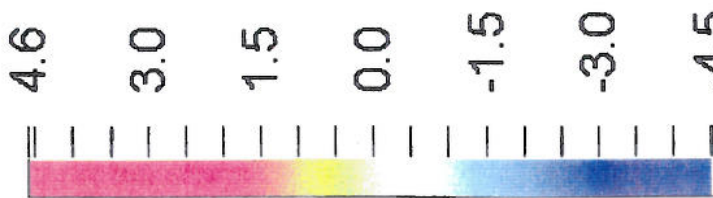
um



Tilt/Power/Astig Removed



nm



# LADI CERTIFICATION DATA

Title: 4ITM051

Date: 11/11/98

Diameter: 200 mm

Astig: 4.2 nm

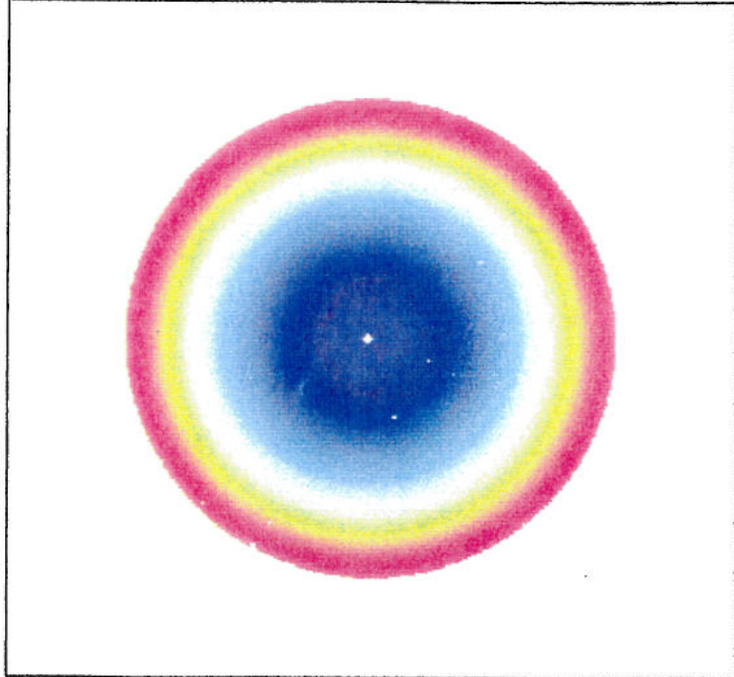
Power: 377.0 nm



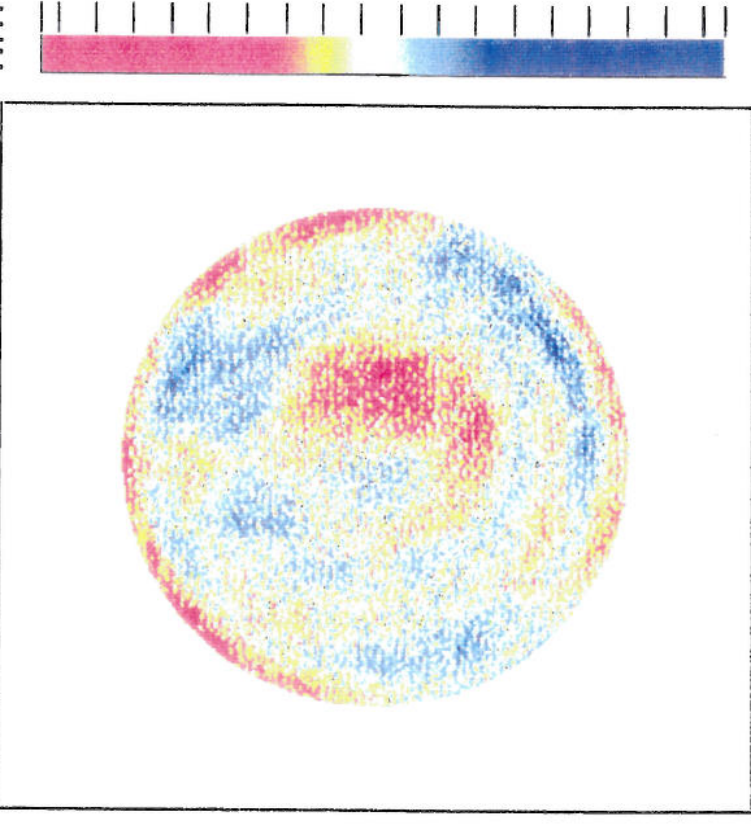
PV: 9.0 nm

RMS: 0.7 nm

Tilt Removed

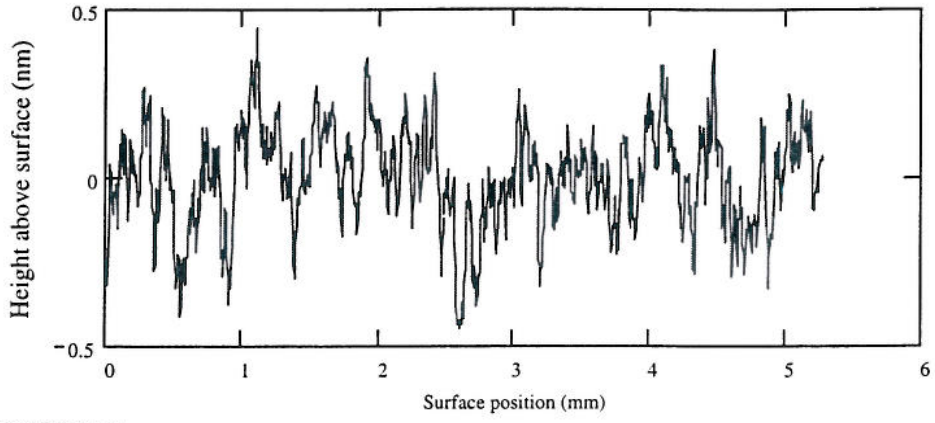


Tilt/Power/Astig Removed

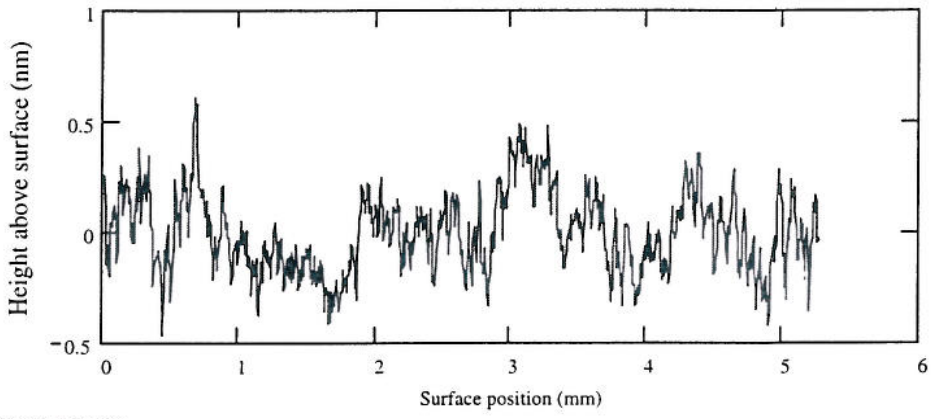


Atch. 1

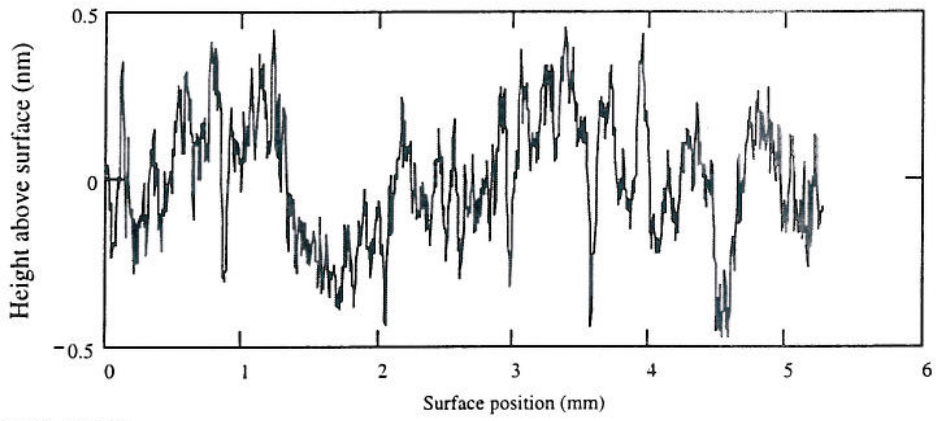




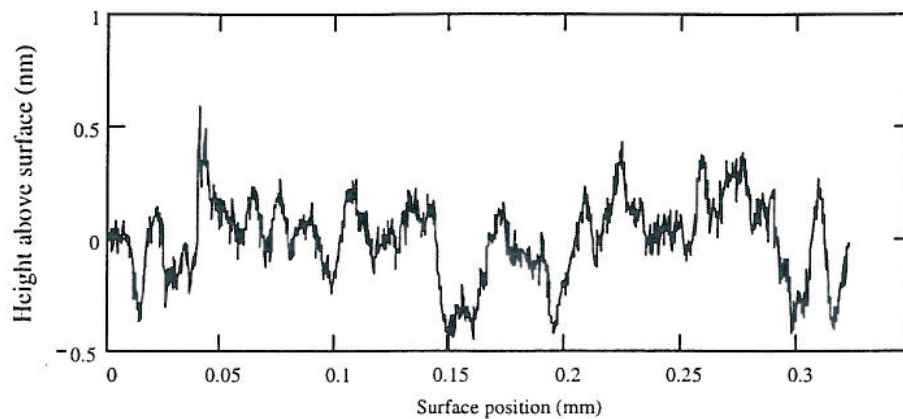
T24IM51A.asc



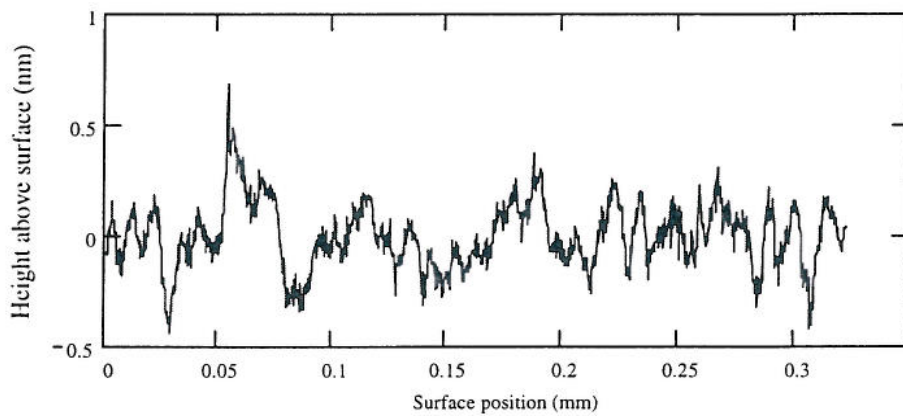
T24IM51B.asc



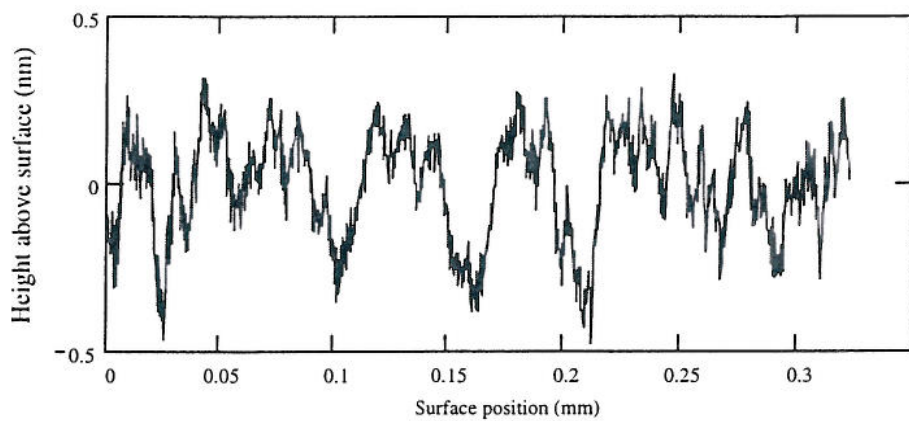
T24IM51C.asc



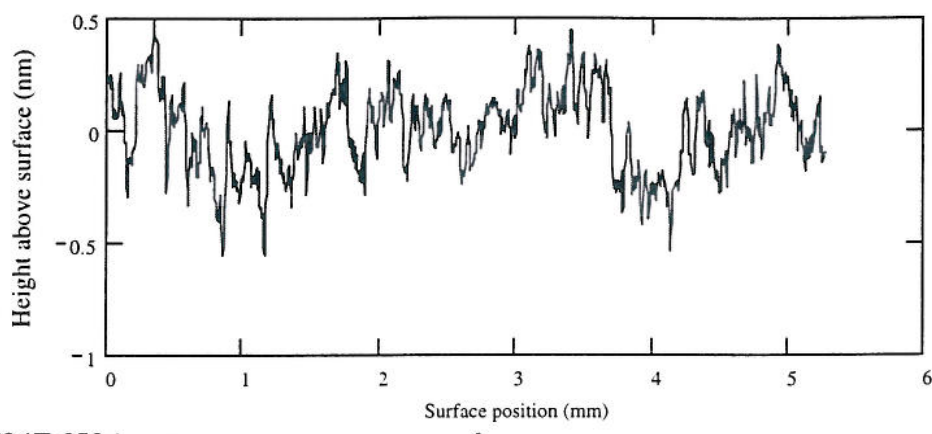
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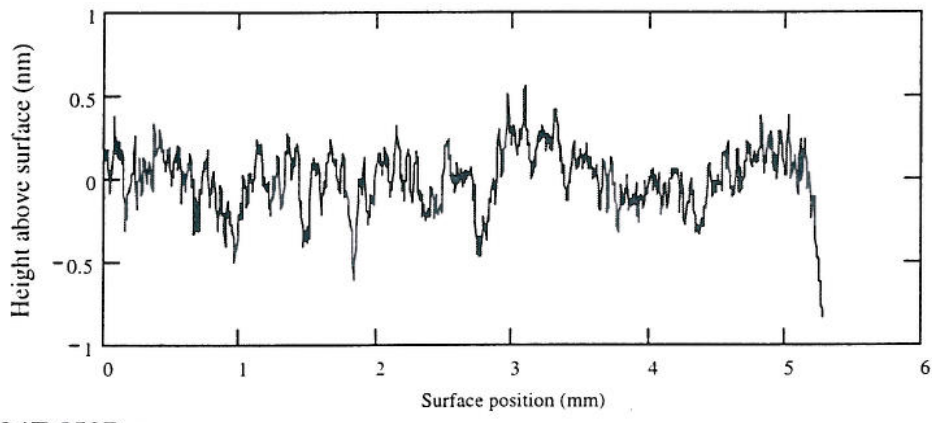
T44IM51B.asc



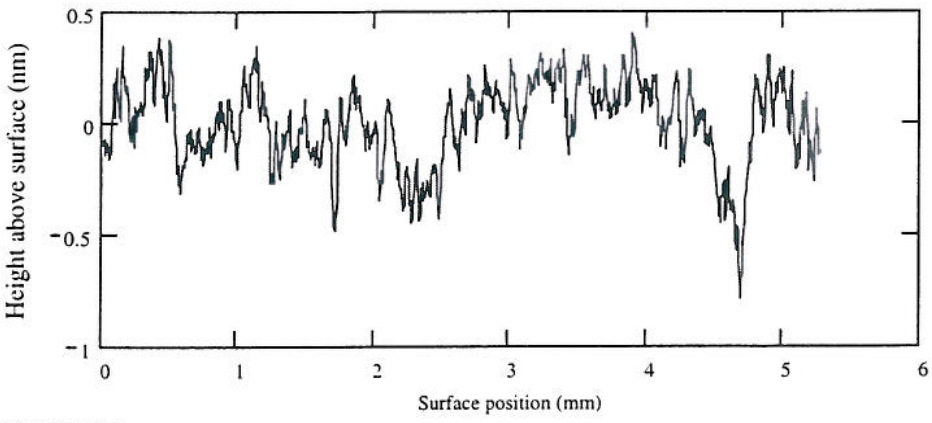
T44IM51C.asc



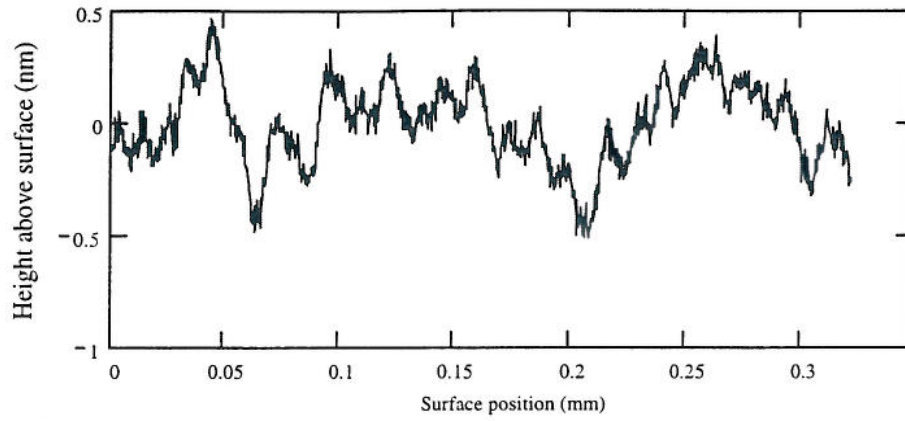
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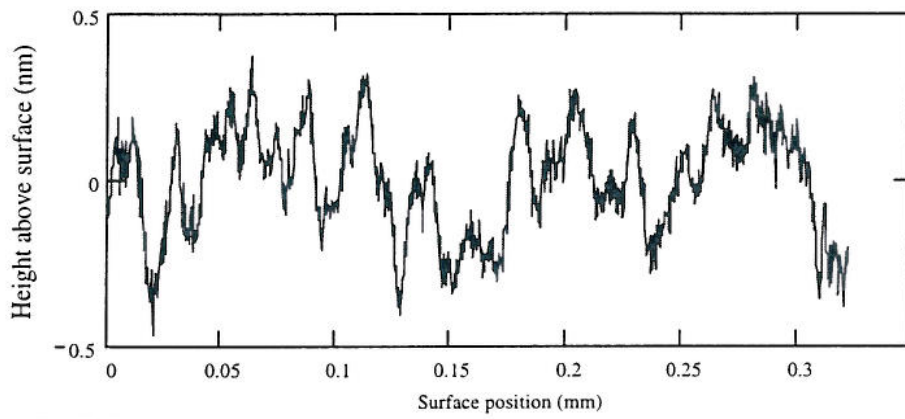
T24IM52B.asc



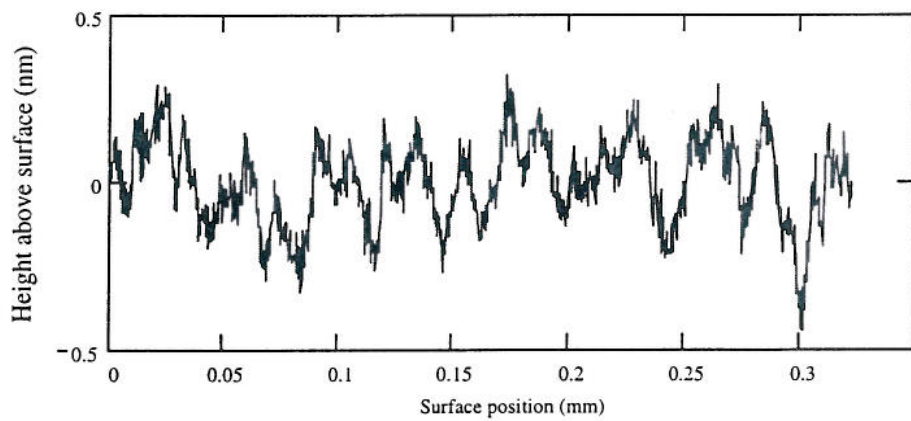
T24IM52C.asc



T44IM52A.asc



T44IM52B.asc



T44IM52C.asc