



Material Lab

P.O Box: 114717, Dubai, United Arab Emirates

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Email: [mld@eim.ae](mailto:mld@eim.ae)

Website: [www.mlab.ae](http://www.mlab.ae)

## Test Reports on Physical, Chemical and Thermal Properties of Bronya Anticor

Client : Bronya  
Address : P.O Box: 299195, SIT Tower, Silicon Oasis, Dubai, U.A.E  
Telephone : +971 4 336 3422  
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Lab Project No. : P – 3004  
Date : 11-August-2015





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ماتيريال لاب  
Material Lab



## 1: INTRODUCTION



Certificate Number: SNR 30362926/4/Q



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Material Lab Gulf Testing Soil - Abu Dhabi: P.O. Box - 61831, Tel. + 971 2 5503040 Fax: +971 2 5503041  
Email: mld@eim.ae Website: www.mlab.ae

### Introduction:

Bronya appointed Material Lab for testing of physical, chemical and thermal properties of Bronya Anticor. The following tests were conducted as requested by the client:

1. Chemical Resistance
2. Resistance to Water
3. Salt Spray Resistance

### Instrumentation:

In order to conduct the above mentioned tests, the following calibrated instruments were used:

- Salt Spray Resistance Apparatus
- Chemical Reagents



### Test Methods:

The test methods followed for conducting the tests requested by Bronya are listed below:

- |                          |                |
|--------------------------|----------------|
| 1. Chemical Resistance   | ASTM D543 - 95 |
| 2. Resistance to Water   | ASTM D543 - 95 |
| 3. Salt Spray Resistance | ASTM B117      |
| 4.                       |                |

### Technical Details (provided by the sponsor):

Technical details of Bronya Anticor are provided below:

"Liquid thermal insulation Bronya Antirust This is the first and unique material developed in Russia which can be applied directly onto the rusted surface. It is enough to just remove loose rust with a wire brush and right after that thermal insulation Bronya Antirust can be applied following its application guide. Extra-fine thermal insulation Bronya Antirust is a special compound with improved adhesion and rust-preventing characteristics. It is resistant to UV light and chemicals (salt solutions, acids, alkali, some types of oil products). The coat increases the service life of isolated surfaces and protects against corrosion.

Extra-fine liquid insulation Bronya Antirust is used for thermal insulation of construction steel structures, metal ware, pipelines, various industrial equipment exposed to high humidity or hostile environment. Operating temperature is from  $-60^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$ .





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## 2: DETAILED TEST REPORTS



Certificate Number: SNR 30362926/A/Q



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**2.1: CHEMICAL RESISTANCE & RESISTANCE TO WATER TEST**  
**REPORT**





## REPORT ON CHEMICAL RESISTANCE TO SOLVENT OF BRONYA ANTICOR

Page: 2 of 2

Client : BRONYA  
Address : P.O.Box Dubai, U.A.E  
Contractor : NP  
Consultant : NP  
Project Name : NP  
Sample Name : Bronya Anticor  
Sample Size (kg) : 5  
Sender's Id : NP  
Client Ref No. : NP  
Sampling Date : 25/07/2015  
Sampled by : Client  
Source of Sample : Client

Report No : 434720 SN 1/1  
Lab Project No : P-3004  
Lab Sample No : 15-434720/6  
Tested by : JD  
Date sample received : 25/07/2015  
Date test started : 28/07/2015  
Date test completed : 10/08/2015  
Report Date : 11/08/2015  
Specimen Size : 0.6 mm ( 2 layer coat)  
Room testing temp. : 25 °C  
Relative humidity : 55%  
Immersion Period : 10 days

### Test Data:-

Type of Solvent	Visual Observation	
	Before Immersion	After Immersion
Distilled Water	gray color smooth thin film specimen	No changes has been observed
Alkali solvent (5% NaOH)	gray color smooth thin film specimen	Color changes has been observed

Test Method : ASTM D 543-95 Practice A-Immersion Test  
Method variation : None  
Remarks : None

  
Authorized Signatory



Result relates only to the item tested.  
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Certificate Number: SNR 30362926/4/Q



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2.2: SALT SPRAY RESISTANCE TEST REPORT



Certificate Number: SNR 30362926/4/Q



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## REPORT ON DETERMINATION OF SALT SPRAY RESISTANCE OF BRONYA ANTICOR

Page 1 of 2

Client	: BRONYA	Report No	: 434720	SN	1/1
Address	: P.O.Box Dubai, U.A.E.	Lab Project No	: P-3004		
Contractor	: NP	Sample No	: 15-434720/1		
Consultant	: NP	Date sample received	: 25/07/2015		
Project Name	: NP	Date test started	: 28/07/2015		
Project No.	: NP	Date test completed	: 03/08/2015		
Sample Description	: Bronya Anticor	Report Date	: 04/08/2015		
Sample size	: 1 container	Size of specimen	: 300 mm x 300 mm		
Client Ref. No.	: NP	Thickness of specimen	: 6 mm		
Marking on the sample	: NP	Pressure of Air applied	: 172 KPa/m <sup>2</sup>		
Source of sample	: NP	Temperature of Chamber	: 35 °C		
Sampled by	: Client	Salt solution used	: 5% NaCl		
Sample brought in by	: Client	Duration of Exposure	: 100 hours		
Date of Sampling	: 25/07/2015	Tested by	: ZIA		
Sample Ref. No.	: NP				

### Introduction:

BRONYA Appointed Material Lab for determination of efficiency of Bronya Anticor against rusted environment.

### Test Methods:

To determine the resistance of the Bronya Anticor the sample was coated on a steel panel with wet film thickness of 0.6mm two layers. The coated specimen was cured at standard condition for 24 hours for each layers. Test specimen was exposed to salt spray for 100 hours. The testing temperature was 35°C while the humidity was 80%. Upon completion of exposure following checks were made on the Bronya Anticor.

- Visual inspection
- Loss in Bond Strength
- Loss in mass
- Reduction in coating thickness
- Corrosion Stains on Base Metals

### Test Result:

S.No	Test Name	Test Results
1	Visual Inspection	Stains were observed in the surface
2	Loss in bond strength	68.0%
3	Loss in Mass	0.02%
4	Reduction in coating thickness	Nil
5	Corrosion Stains on Base Metals	12%

Test method : ASTM B 117-97  
Conditioning of specimen : ASTM B 117-97 Section 10.0  
Method variation : Nil  
Remarks : Sample was prepared by client.

Results relate only to the item tested.

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Authorized Signatory

002  
سهيل ظفر  
Sohail Zafar  
Laboratory Manager

Certificate Number: SNR 30352926/4/Q



ماتيريال لاب دبي، دولة الامارات العربية المتحدة  
ماتيريال لاب أبو ظبي، دولة الامارات العربية المتحدة  
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### 3: SUMMARY OF ALL TESTS



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Below is the summary of all tests conducted on Bronya Anticor:

Sr. No.	Test Description	Test Method	Unit	Test Result
1	Chemical Resistance	ASTM D543-95	observation	Colour change
2	Resistance to Water	ASTM D543-95	observation	No change
3	Salt Spray Resistance			
3.1	Visual Inspection	ASTM B117-97	observation	Stains observed
3.2	Loss in bond strength		%	68.0
3.3	Loss in mass		%	0.02
3.4	Corrosion stains on base materials		%	12

Summary of all tests conducted





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#### 4: TECHNICAL DATA SHEET



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5: ACCREDITATION CERTIFICATES



Certificate Number: SNR 30362926/4/Q



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هيئة الإمارات للمواصفات والمقاييس  
Emirates Authority For Standardization & Metrology



## Certificate of Accreditation

ماتيريال لاب (NAL-68)  
القوز - دبي - الإمارات العربية المتحدة ( Al Quoz - Dubai, UAE )

ISO/IEC 17025:2005: وفقاً للمتطلبات الدولية؛  
Accredited according to ISO/IEC 17025 to undertake tests in the field(s) of "Construction material as per attached Test Methods"

تاريخ منح الاعتماد 2014/06/12  
تاريخ الانتهاء 2017/06/11



رئيس مجلس إدارة هيئة الإمارات للمواصفات والمقاييس

Accreditation in accordance with the requirements of ISO/IEC 17025:2005 "requirements for testing and calibration laboratories" & the relevant ENAS & ILAC guidelines.  
This certificate is invalid without the attached scope of accreditation and shall remain valid until the expiration date above, subject to continuing compliance with the requirements of the accreditation system.

1 وفقاً لمتطلبات المواصفة الدولية ISO/IEC 17025:2005 "المتطلبات العامة لكفاءة مختبرات الفحص والمعايرة" والأدلة ذات العلاقة الخاصة بالمنظمة الدولية لاعتماد المختبرات ILAC للقيام بالانشطة الواردة في وثيقة المجال.  
تعتبر هذه الشهادة صالحة وقابلة للتحديث وإعادة الاعتماد حتى تاريخ الانتهاء الممنون أعلاه بشرط استمرار الجهة المذكورة أعلاه في تطبيق متطلبات المواصفات والأدلة سالفة الذكر. وتتحمل الجهة مسؤولة الشهادات الصادرة عنها وتوضع مجالات الاعتماد المذكورة في وثيقة المجال المرقة لعمليات متابعة لاحقة من قبل نظام الاعتماد الوطني.

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فاكس: +971 4 2944428  
ACF 11-21: Rev 1; issue date 19.03.2014

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United Arab Emirates

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Emirates Authority For Standardization & Metrology



## Accreditation Scope

MATERIAL LAB, Dubai, NAL 068  
Testing Lab, Al Quoz, Dubai, UAE

#	Test Material /Matrix	Description of the Test	Tested Method/Standard
---	-----------------------	-------------------------	------------------------

1.	Concrete	Solar Reflective Index	ASTM E 1980	
2.		Thermal Conductivity	ASTM C 518	
3.	Asphalt	Determination of bitumen content by ignition method	ASTM D 6307	
4.		Sieve analysis of extracted aggregates	ASTM D 5444	
5.		Marshal properties Voids (VIM, VMA, VFB)	MS-2	
6.		Stability flow stiffness	ASTM D 6927	
7.		Determination of marshal density	ASTM D 2726	
8.		Thickness and density of compacted bituminous mixtures	ASTM D 3549	
9.		Cement	Dimensions compressive strength of cement	EN 196 Part 1
10.			Setting time	EN 196 Part 3
11.	Fineness of cement		ASTM C 204	

END

Emirates National Accreditation System



Program Manager's signature





**Quality Management System  
Certificate of Approval**

This is to certify that the QMS of

**MATERIAL LAB**

P.O. BOX 114717, DUBAI, U.A.E.

Has been assessed and found to meet the requirements of

**ISO 9001:2008**

This certificate is valid for the following scope of operations:

**OIL & PETROLEUM PRODUCTS TESTING, CONSTRUCTION MATERIAL TESTING, GEO-TECHNICAL INVESTIGATION ENVIRONMENT TESTING, NOISE MONITORING, GLASS TESTING, ACOUSTIC TESTING & FIRE RESISTANCE TESTING**

Authorised by:

**Stan Wright  
Chief Executive**

**Date of Certificate Issue: 22 May 2015**

**Certificate Valid Until: 21 May 2016**

Recertification audit before 21 April 2018. Certified since 22 May 2015.

This certificate is the property of DAS Certification and remains valid subject to satisfactory annual Surveillance audits.

**SN Registrars (Holdings) Limited**

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Rushden, Northamptonshire,  
NN10 9YT, UK  
Tel: +44 (0) 1933 381859  
Email: [info@snregistrars.com](mailto:info@snregistrars.com)  
Web: [www.snregistrars.com](http://www.snregistrars.com)  
Company number: 07659067

Certificate Number: SNR 30362926/4/Q



Member of SN Registrars (Holdings) Ltd

8327





# ACCREDITATION CERTIFICATE

**LB-008-TEST**

*Dubai Accreditation Department*

*has accredited*

**Material Lab**

**Dubai- United Arab Emirates**

In accordance with the requirements of ISO/ IEC 17025: 2005 to undertake the tests in the fields of:

**Construction Materials Testing  
Geotechnical Investigation  
Environmental Testing**

For the tasks listed in the attached Scope of Accreditation

This Accreditation is invalid without the attached scope of accreditation and shall remain in force within the validity period printed below, subject to continuing compliance with the requirements of the accreditation program.

**Validity of Certificate: from 25- 01- 2015 to 06- 03- 2016**

Initial Accreditation Date: 05- 02- 2004

  
Director, Dubai Accreditation Department



6: CALIBRATION CERTIFICATES





### Certificate of Calibration

#### TEMPERATURE LOGGER

SERIAL NO : 150501100

Issue date	Calibration date	Calibration due	Certificate No:	DCML/40847/2015	
15.07.2015	13.07.2015	13.07.2016*	Job No:	19758	
ISSUED TO:	MATERIAL LAB DUBAI, U.A.E.		ISSUED FOR	Not applicable	
Details of equipment under test			Details of working standards used		
Make	CENTER		Equipment	ID No:	Certificate No.
Model :	309		Digital thermometer with PRT	18A-1294	2013085668
Serial No: of readout :	150501100			DCML/T-22	
Sensor used	"K" type thermocouple wire		Environmental conditions		Calibrated by
Asset No :	DL-31		Temperature °C	Humidity %	
Ranges : in °C	-200 to 1370		22.7	35	Vahid
Readability :	0.1°C upto 200°C then 1°C		CONDITION : The EUC is in working order when received		
Location	Danway Lab, Al Quoz Ind. area # 3, Plot # 368-303		for calibration		

#### Traceability Statement :

All the temperature measurements reported in this certificate are traceable to ITS-90 through the calibration performed by DCL (Lab # LB 014) an accredited lab by DAC.

#### Calibration method (DCML-T/WI-001):

The sensor of the temperature logger under calibration and two numbers of PRT were immersed in a temperature controlled bath. One PRT is used as the master thermometer and the other as a check standard.

The readings of the EUT and master thermometer were compared to find the error in indication of the EUT.

Deviation : Repeatability test was not done as the EUT records the temperature after certain intervals.

\* Note : As per clause 5.10.4.4, of ISO/IEC 17025 : 2005, a calibration certificate shall not contain any recommendation on the calibration interval except where this has been agreed with the customer.

#### Calibration Results in °C (Channel-T1)

Actual temperature (Average) in °C	Indicated temperature	Error in °C	Uncertainty in ± °C
10.545	10.4	-0.145	0.2
25.640	25.7	0.060	0.2
50.047	49.6	-0.447	0.2
76.691	76.2	-0.491	0.2
101.511	101.1	-0.411	0.2

APPROVED SIGNATORY.....

K. Ravindranath (Manager DCML)



The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95%. The uncertainties stated in this certificate refer to the values obtained during the verification and make no allowances for any drift.

This certificate may not be reproduced other than in full without the written approval of DCML.

DCML is not responsible for any consequences due to the improper usage of the equipment.

Continuation Sheet  
TEMPERATURE LOGGER  
SERIAL NO : 150501100

DCML/40847/2015

Calibration Results in °C (Channel-T2)

Actual temperature (Average) in °C	Indicated temperature	Error in °C	Uncertainty in ± °C
10.545	10.8	0.255	0.2
25.637	25.4	-0.237	0.2
50.051	49.7	-0.351	0.2
76.691	76.4	-0.291	0.2
101.509	101.0	-0.509	0.2

Calibration Results in °C (Channel-T3)

Actual temperature (Average) in °C	Indicated temperature	Error in °C	Uncertainty in ± °C
10.553	10.6	0.047	0.2
25.633	25.4	-0.233	0.2
50.047	49.7	-0.347	0.2
76.683	76.1	-0.583	0.2
101.509	101.0	-0.509	0.2

Calibration Results in °C (Channel-T4)

Actual temperature (Average) in °C	Indicated temperature	Error in °C	Uncertainty in ± °C
10.550	10.7	0.150	0.2
25.635	25.7	0.065	0.2
50.050	49.2	-0.850	0.2
76.685	76.4	-0.285	0.2
101.507	101.0	-0.507	0.2

*Handwritten signature*



WWR  
INTERNATIONAL



UTM-2  
ASST

# BDH LABORATORIES

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Tel : +971 4 2852211, Fax : +971 4 2863666  
E-mail : calibrationsales@bdhme.com, www.bdhcallab.com

## CERTIFICATE OF CALIBRATION

Certificate No. BDH/2014/3771/01	Page 1 of 2
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### NAME & ADDRESS OF THE CUSTOMER

Material Lab  
P.O. Box: 114717, Al Quoz, Dubai, United Arab Emirates

### DESCRIPTION OF THE UNIT UNDER CALIBRATION

#### Unit Under Test

Name of Instrument Universal Testing Machine  
Type Digital  
Make Tinius Olsen  
Model H25KT  
Machine Capacity 25 kN  
Sr. No H25KT-0084  
ID No -NA-  
Load cell Capacity -NA-  
Load cell Sr. No -NA-

#### Calibration Conditions

Date of calibration 14/12/2014  
Recommended Due Date 13/12/2015  
Temperature 23 ± 5 °C  
Humidity 50 ± 15 %  
Location Lab  
Calibrated by Gene & Prashant  
Condition on receipt Good  
Date of receipt 14/12/2014  
Mode of calibration Tension

### DETAILS OF MASTER EQUIPMENTS

	Load cell 1	Weights
Capacity	5kN	1 to 200N
ID No.	LC-05	CDW-15
Certificate No	UME G2KV-0042	Z13 13118
Calibration Due Date	17.05.2015	02.12.2015
Traceable To	UME, Turkey	COFRAC

### METHODOLOGY

The machine is calibrated using indicated force method. Force is applied from the machine & the true force is measured on the master force measuring instrument. Three series are taken & the relative accuracy & repeatability errors are calculated. For Class A, the tolerances for relative accuracy & repeatability errors are 1%. The referred method is ASTM E4 - 10 & the internal work instructions is WI-44 Iss.No.00 dtd 1.11.14. The calibration is traceable to international standards by calibration at NMI. Uncertainty is calculated as per the ISO 17025 guideline.

### VISUAL INSPECTION CHECK LIST FOUND SATISFACTORY

- \* Machine is in good working condition
- \* Crosshead mechanism permits uniform & smooth variation of force to be verified with sufficient accuracy.
- \* M/c structure & gripping systems permit for axial loading.
- \* There is no pronounced wear or defects in the guiding elements of the moving crosshead or grips.
- \* Flatness of the loading platen is found satisfactory.
- \* Machine structure & gripping systems permit for axial loading.
- \* Machine is not affected by any other environmental conditions like vibrations electrical supply interferences , effects of corrosion & local temperature variations etc.

Checked By

Gene Palor  
(Calibration Engineer)

**BDH Laboratories**  
Calibration Division  
P.O. Box: 28637, Dubai - U.A.E.

Approved By

Prashant Aklekar  
(Tech. Manager)

DOC NO. BDH/1.1 ISSUE NO. 04 DT. 18.03.2014

ص.ب: ٢٨٦٣٧، دبي - ا.ع.م. الطابق الأرضي، بناية البندري، شارع ١٣، أم رمول المنطقة الصناعية، الراشدية  
www.bdhcallab.com، ويب: calibrationsales@bdhme.com، +٩٧١ ٤ ٢٨٦٣٦٦٦، فاكس: +٩٧١ ٤ ٢٨٥٢٢١١، تليفون:  
سجل تجاري رقم: ٦٤٥٩٦٢ والراسمال المدفوع: ٣٠٠ ألف درهم

Commercial Registration No. 645962 and paid up capital AED 300 Thousand.



VWR  
INTERNATIONAL



# BDH LABORATORIES

P.O. Box : 28637, Ground Floor, Al Bindrei Building, 13 St.

Umm Ramool Ind. Area, Al Rashidiya, Dubai, U.A.E

Tel : +971 4 2852211, Fax : +971 4 2863666

E-mail : calibrationsales@bdhme.com, www.bdhcallab.com

Continuation Sheet No. 2

Certificate No. BDH/2014/3771/01	Page 2 of 4
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## CALIBRATION RESULTS

Load cell used	Load N	Std. Rdg.	Observed Readings			Mean	% Rel. Accuracy Error	% Rel. Repeatability Error	% Exp. Uncertainty
			0 °	120 °	240 °				
5kN	200	200.01	200.8	200.9	200.9	200.87	-0.43	0.05	0.30
5kN	800	799.98	800.1	800.0	800.9	800.33	-0.04	0.11	0.30
5kN	1400	1399.85	1400.1	1400.9	1400.9	1400.63	-0.06	0.06	0.30
5kN	2000	1999.62	2000.8	2001.8	2001.3	2001.30	-0.08	0.05	0.30
25kN	2000	1995.5	2000.3	2000.7	2001.2	2000.73	-0.26	0.04	0.30
25kN	8000	7986.1	8000.1	8001.9	8002.0	8001.33	-0.19	0.02	0.30
25kN	10000	9984.1	9998.1	9999.1	9999.8	9999.00	-0.15	0.02	0.30
25kN	15000	14981.1	14997.1	14999.8	14998.2	14998.37	-0.12	0.02	0.30
25kN	20000	19979.6	19993.8	19989.7	19996.4	19993.30	-0.07	0.03	0.30
25kN	25000	24978.5	24999.8	24996.7	24999.0	24998.50	-0.08	0.01	0.30
Residual load			1.7	3.2	1.9	Classification of M/c			ClassA
Range I			20 to 25000 N			Resolution			0.8 kN

25kN - S/N: 0243570 - ID. NO. LC-01

**Remarks :** The machine has been calibrated by increasing force only & is not adjusted prior to calibration. The machine was not be checked for eccentricity.

Checked By

Gene Palor  
(Calibration Engineer)

**BDH Laboratories**  
Calibration Division  
P.O. Box: 28637, Dubai - U.A.E.

Approved By

Prashant Aklekar  
(Tech. Manager)

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- \* Any correction in this certificate, invalidates the certificate.
- \* BDH Laboratories is not liable for any change in calibration data and performance on account of malfunctioning of instrument / equipment covered by this report or due to damage caused to it after issuance of this report.
- \* Uncertainty of Measurement is at 95 % Confidence level with k=2 & the measurements are traceable to National / International Standards.
- \* Our calibrated load cells are temperature compensated, so accordingly correction is not required.
- \* The machine shall in any case be re- calibrated if it is moved to a new location necessitating dismantling or if it is subjected to major repairs or adjustments.

DOC NO. BDH/1.44 ISSUE NO. 00.DT.01.11.2014

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تليفون: ٢٨٥٢٢١١ ٤ +٩٧١، فاكس: ٢٨٦٣٦٦٦ ٤ +٩٧١، ايميل: calibrationsales@bdhme.com، ويب: www.bdhcallab.com

Commercial Registration No. 645962 and paid up capital AED 300 Thousand. سجل تجاري رقم: ٦٤٥٩٦٢ والراسمال المدفوع: ٣٠٠ ألف درهم



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Continuation Sheet No. 4

Certificate No.	BDH/2014/3771/01	Page	4	of	4
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## CALIBRATION RESULTS

Load cell used	Load N	Std. Rdg.	Observed Readings			Mean	% Rel. Accuracy Error	% Rel. Repeatability Error	% Exp. Uncertainty
			0 °	120 °	240 °				
Weights	40	39.86	39.7	39.7	39.7	39.70	0.40	0.00	0.30
Weights	160	159.43	158.9	158.9	158.7	158.83	0.37	0.13	0.30
Weights	280	278.99	278.6	278.6	278.6	278.60	0.14	0.00	0.30
Weights	400	398.56	396.4	396.4	396.4	396.40	0.54	0.00	0.30
5kN	400	400.01	403.1	403.2	403.2	403.17	-0.79	0.02	0.30
5kN	1000	999.95	1001.4	1001.6	1002.0	1001.67	-0.17	0.06	0.30
5kN	2000	1999.62	2002.3	2003.1	2004.0	2003.13	-0.18	0.08	0.30
5kN	3000	2999.05	3005.1	3008.6	3009.9	3007.87	-0.29	0.16	0.30
5kN	4000	3998.26	4009.1	4010.1	4011.6	4010.27	-0.30	0.06	0.30
5kN	5000	4997.26	5009.8	5015.6	5018.1	5014.50	-0.34	0.17	0.30
Residual load			0.8	1.7	2.0	Classification of M/c			ClassA
Range I			40 to 5000N			Resolution			0.2 N

5kN - S/N: 180463 - ID. NO. LC-02

**Remarks :** The machine has been calibrated by increasing force only & is not adjusted prior to calibration.  
The machine was not be checked for eccentricity.

Checked By

Gene Palor  
(Calibration Engineer)

**BDH Laboratories**  
Calibration Division  
P.O. Box: 28637, Dubai - U.A.E.

Approved By

Prashant Aklekar  
(Tech. Manager)

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- \* Uncertainty of Measurement is at 95 % Confidence level with k=2 & the measurements are traceable to National / International Standards.
- \* Our calibrated load cells are temperature compensated, so accordingly correction is not required.
- \* The machine shall in any case be re- calibrated if it is moved to a new location necessitating dismantling or if it is subjected to major repairs or adjustments.

DOC NO. BDH/1.1 ISSUE NO. 04 DT. 18.03.2014

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تليفون: ٢٨٥٢٣١١ +٩٧١ ٤، فاكس: ٢٨٦٣٦٦٦ +٩٧١ ٤، ايميل: calibrationsales@bdhme.com، ويب: www.bdhcallab.com

Commercial Registration No. 645962 and paid up capital AED 300 Thousand. سجل تجاري رقم: ٦٤٥٩٦٢ والراسمال المدفوع: ٣٠٠ ألف درهم

Continuation Sheet No. 3

Certificate No.	BDH/2014/3771/01	Page	3	of	4
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### CALIBRATION RESULTS

Load cell used	Load N	Std. Rdg.	Observed Readings			Mean	% Rel. Accuracy Error	% Rel. Repeatability Error	% Exp. Uncertainty
			0 °	120 °	240 °				
Weights	20	19.928	19.95	19.95	19.95	19.950	-0.11	0.00	0.30
Weights	80	79.712	79.70	79.70	79.70	79.700	0.02	0.00	0.30
Weights	140	139.498	139.52	139.52	139.52	139.520	-0.02	0.00	0.30
Weights	200	199.279	199.50	199.50	199.50	199.500	-0.11	0.00	0.30
Weights	220	219.207	219.52	219.52	219.52	219.520	-0.14	0.00	0.30
Weights	360	358.70	359.48	359.48	359.48	359.480	-0.22	0.00	0.30
Weights	360	360.01	359.8	359.1	359.2	359.37	0.18	0.19	0.30
Weights	500	500.01	499	499	499	499.2	0.17	0.06	0.30
Residual load			0.06	0.01	0.02	Classification of M/c			ClassA
Range I			20 to 500N			Resolution			0.08 N

500N - S/N: 176555 - ID. NO. LC-03

**Remarks :** The machine has been calibrated by increasing force only & is not adjusted prior to calibration. The machine was not be checked for eccentricity.

Checked By



Gene Palor  
(Calibration Engineer)

**BDH Laboratories**  
Calibration Division  
P.O. Box: 28637, Dubai - U.A.E.

Approved By



Prashant Aklekar  
(Tech. Manager)

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- \* Uncertainty of Measurement is at 95 % Confidence level with k=2 & the measurements are traceable to National / International Standards.
- \* Our calibrated load cells are temperature compensated, so accordingly correction is not required.
- \* The machine shall in any case be re- calibrated if it is moved to a new location necessitating dismantling or if it is subjected to major repairs or adjustments.

DOC NO:BDH/1.44 ISSUE NO.00 DT.01.11.2014





# Certificate of Analysis

---

## Certipur<sup>®</sup> Certified Reference Material

<b>Producer:</b>	Merck KGaA, Frankfurter Str. 250, 64293 Darmstadt, Germany.
<b>Description of CRM:</b>	<b>ICP multi-element standard solution IV</b>
<b>Ord. No.:</b>	1.11355.0100
<b>Lot No.:</b>	HC379062
<b>Composition:</b>	23 elements in HNO <sub>3</sub> Suprapur <sup>®</sup> 6.5%
<b>Density:</b>	The density of the standard solution is 1.090 g/cm <sup>3</sup> at 20°C.
<b>Method of Analysis:</b>	Inductively coupled plasma optical emission spectrometry (ICP-OES).
<b>Traceability:</b>	This reference material has been measured applying high precision ICP-OES and is directly traceable to the corresponding <b>NIST SRM<sup>®</sup></b> as mentioned on page 2. <i>NIST: National Institute of Standards and Technology, Gaithersburg, USA.</i>
<b>Storage:</b>	Store at +15°C to +25°C tightly closed in the original container.
<b>Application and correct use:</b>	This reference material is intended for use as <b>calibration standard</b> for atomic absorption spectrometry, spectrophotometry and other analytical techniques. Shake well before use and never pipet directly from the original container.
<b>Date of release:</b>	2013/03/11
<b>Minimum shelf life:</b>	2016/03/31



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TC-01  
Shibin

# BDH LABORATORIES

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E-mail : calibrationsales@bdhme.com, www.bdhcallab.com

## CERTIFICATE OF CALIBRATION

Date of Issue -	09/02/2015	Certificate No.	BDH/2015/A0035/02	Page 1 of 1
-----------------	------------	-----------------	-------------------	-------------

### NAME & ADDRESS OF THE CUSTOMER

MATERIAL LAB  
P.O. Box: 114717, Al Quoz, Dubai, United Arab Emirates

### DETAILS OF INSTRUMENT UNDER CALIBRATION

#### UNIT UNDER TEST

Name of Instrument Heat Flow Meter  
Type Digital  
Make Lasercomp  
Model -NA-  
Calibrated Points 30 and 40°C  
Sr. No. 06120864  
ID No. TC-01  
Resolution 0.01 °C

#### CALIBRATION CONDITIONS

Calibrated On 09/02/2015  
Recommended Due Date 08/02/2016  
Temperature 23±5°C  
Humidity 50±15%RH  
Location Chemical Lab  
Calibrated By Rafsal / Shibin  
Condition on receipt Good

### DETAILS OF MASTER EQUIPMENT USED FOR CALIBRATION

Description Digital Thermometer with RTD Sensor  
Sr. No / ID No. 12029291 / 12033601 / 12033604  
(DTI-01, MTS-23 & MTS-24)  
Calibration Due Date 29.06.2015  
Traceability NIST

### CALIBRATION RESULTS

Upper	Set Temperature (°C)	Standard Reading (°C)	UUC Reading (°C)	Deviation (°C)
Center	30.00	30.43	30.03	-0.40
Left	30.00	30.47	30.02	-0.45
Right	30.00	30.46	30.02	-0.44
Back	30.00	30.45	30.03	-0.42
Front	30.00	30.43	30.03	-0.40

Lower	Set Temperature (°C)	Standard Reading (°C)	UUC Reading (°C)	Deviation (°C)
Center	40.00	40.37	40.02	-0.35
Left	40.00	40.42	40.03	-0.39
Right	40.00	40.43	40.03	-0.40
Back	40.00	40.42	40.02	-0.40
Front	40.00	40.42	40.02	-0.40

Mean Temperature = 35.44°C

Checked By

Shibin Joseph Mathew  
(Calibration Engineer)

BDH Laboratories  
Calibration Division  
P.O. Box: 28637, Dubai - U.A.E.

Approved Signatory

Prashant Aklekar  
(Tech. Manager)

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- BDH Laboratories is not liable for any change in calibration data or performance specifications on account of malfunctioning of standard instrument / Equipment covered by this report or due to damage caused to it after issuance of this report.

DOC NO. BDH/1.7 ISSUE NO.01 DT. 09.03.2014

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تليفون: ٢٨٥٢٣١١ ٤ ٩٧١، فاكس: ٢٨٦٣٦٦٦ ٤ ٩٧١، ايميل: calibrationsales@bdhme.com, ويب: www.bdhcallab.com

Commercial Registration No. 645962 and paid up capital AED 300 Thousand. سجل تجاري رقم: ٦٤٥٩٦٢ والراسمال المدفوع: ٣٠٠ ألف درهم

# Certificate of Calibration

## HUMIDITY CHAMBER

SERIAL NO : 1597

Issue Date : 30.10.2014

Certificate No : DCML/37768/2014

Job No : 18195

FOR:

MATERIAL LAB  
DUBAI, U.A.E.

IDENTIFICATION:

Make : OSWORLD  
Model : OSC-S-4  
Serial No : 1597  
Asset No : OI-1  
Range : 0 to 100°C  
Readability : 0.1°C  
Location : Lab, Al Quoz

DATE OF CALIBRATION:

29.10.2014

CALIBRATION DUE ON:

29.10.2015 (See Noe 1)\*

BASIS OF CALIBRATION:

DCML-T/WI-002 Based on DKD Guideline DKD-R 5-7

CALIBRATED BY:

Renju Pillai

CALIBRATION TEMPERATURE (AVERAGE) : 22.5°C

REFERENCE EQUIPMENT USED :

Digital thermometer with thermocouple Asset No : DCML/T-01, Calibrated against the thermometer Asset No : DCML/T-22 Calibrated By DCL . Certificate No : DCML/37496/2014

Note 1 :

As per clause 5.10.4.4, of ISO/IEC 17025 : 2005, a calibration certificate shall not contain any recommendation on the calibration interval except where this has been agreed with the customer.


Traceability Statement:

All the temperature measurements reported in this certificate are traceable to ITS-90.

METHOD :

The temperature of the chamber is checked at 5 points inside the volume including the geometric center of the equipment. 10 readings have been taken in a specified time interval and the average is taken for calculating the temperature error at each point. The geometric center of the useful volume is selected as reference locations for determining the spatial inhomogeneity.

APPROVED SIGNATORY

  
K. Ravindranath  
Manager DCML

This certificate may not be reproduced other than in full, without the written approval of Danway Calibration &amp; Measurement Lab

The measurement uncertainties for the temperatures were determined from the uncertainties of the standards, of the measurement procedures applied and of the characteristics of climatic chambers investigated. The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor  $k = 2$ , providing a level of confidence of approximately 95%. The uncertainties stated in this certificate are refer to the values obtained during the verification and make no allowances for due to the continuous use of the equipment.

Continuation Sheet  
HUMIDITY CHAMBER  
SERIAL NO : 1597

Certificate No :DCML/37768/2014

Measurement Results : (Set Point : 30°C)

Temperaure Sensor Location	Controller Set Point in °C	Measured Temperature at reference Point (average) in °C	Indication of Chamber (Average) in °C	Correction of Indication in °C
Center	30.0	29.43	30.0	-0.57
Back Middle	30.0	29.45	30.0	-0.55
Front Middle	30.0	29.50	30.0	-0.50
Left Middle	30.0	29.49	30.0	-0.51
Right Middle	30.0	29.39	30.0	-0.61

Results for the Charecterization of the Chamber Volume :  
Temperature

Controller Set Point in °C	Temporal Instability in °C	Spatial Inhomogeneity in °C	Uncertainty of Incubator calibration
30	0.4	0.07	1.6

Remarks :

The results stated are valid only for the useful volume of the climatic chamber spanned by the measuring locations. All other parts of the chamber volume are considered not to be calibrated

*km*

## CERTIFICATE OF CALIBRATION

Certificate No: 15021182

Date: 08-02-2015

Job No: 2732

Customer: Material Lab

Rev: 00

Address: P.O. Box: 114717, Dubai, United Arab Emirates

Page: 1/2

<b>Equipment Description:</b>	Pull-Off Adhesion Tester	<b>Status:</b>	Calibrated
<b>Manufacturer:</b>	DE FELSKO		
<b>Model:</b>	POSITEST AT-A		
<b>S/No:</b>	AT 05193		
<b>Range:</b>	3.5 Mpa/0~500 Psi		
<b>Readability:</b>	0.01 Mpa/ 1 Psi		
<b>Accuracy:</b>	± 1 % full scale		
<b>Standard:</b>	ASTM C900		

<b>Calibration Date:</b>	08-02-2015	<b>Calibration Due:</b>	07-02-2016
--------------------------	------------	-------------------------	------------

<b>Environmental Conditions</b>	
<b>Temperature:</b>	(23 ± 2) °C
<b>Humidity:</b>	(50 ± 10) % RH

The uncertainty limits quoted refer to the measured values only, with no account being taken of the instruments ability to maintain its calibration.

Reference Equipment Details:			Procedure	WI-086
Description	Serial No.	Make	Model	Traceable Standard
Load Cell	C140-08/AB/0006 C138PN186/AB/0001	MATEST	C140-08 C138PN186	UKAS

### Result:

APPLIED Mpa	MEASURED Mpa	ERROR Mpa
0.35	0.322	-0.028
0.70	0.686	-0.014
1.05	1.028	-0.022
1.40	1.378	-0.022
1.75	1.760	0.001
2.10	2.107	0.007
2.45	2.466	0.016

This certificate is issued in accordance with the laboratory accreditation requirement of American National Standard for calibration i.e. ANSI/NCSL Z540-1, General requirements for the competence of calibration laboratories and measuring and test equipment. All measurements recorded in this certificate are traceable back to recognized international standards. The references listed above are subjected to regular verification. This certificate may not be reproduced other than in full except with prior written approval of issuing laboratory. We hereby confirm that the Quality Management System of BETALINK complies with ISO 9001: 2008, ISO 14001:2004, OHSAS 18001:2007, ISO 17020:2012 (ENAS & DAC accreditation) & ISO 17025:2005 (ENAS accreditations).

Doc. No: QF-11/00

Rev: 01



## CERTIFICATE OF CALIBRATION

Certificate No: 15021182	Date: 08-02-2015	Job No: 2732
Customer: Material Lab		Rev: 00
Address: P.O. Box: 114717, Dubai, United Arab Emirates		Page: 2/2

APPLIED Mpa	MEASURED Mpa	ERROR Mpa
2.80	2.803	0.003
3.15	3.122	-0.028
3.50	3.485	-0.015

**Remarks:** Betalink Instrumentation & Calibration Services LLC. here by certify that the above-described " Pull Off Adhesion Tester " tested output & all accessories as per vendor recommended specifications, found to be working satisfactorily.

End of Results



Calibration Engineer:

Lab Manager:

This certificate is issued in accordance with the laboratory accreditation requirement of American National Standard for calibration i.e. ANSI/NCSL Z540-1, General requirements for the competence of calibration laboratories and measuring and test equipment. All measurements recorded in this certificate are traceable back to recognized international standards. The references listed above are subjected to regular verification. This certificate may not be reproduced other than in full except with prior written approval of issuing laboratory. We hereby confirm that the Quality Management System of BETALINK complies with ISO 9001: 2008, ISO 14001:2004, OHSAS 18001:2007, ISO 17020:2012 (ENAS & DAC accreditation) & ISO 17025:2005 (ENAS accreditations).

Doc. No: QF-11/00

Rev: 01

<b>OMT Solutions BV</b> <i>Optical Measurements and Testing</i> <i>Materials for optical applications</i> <i>Thin Film Analysis</i>	DOC. NO. :	REP-212053-01
	ISSUE :	1
	DATE :	27/03/2013
	AUTHOR :	M.M.A.L. Dominicus – van den Acker
	PROJECT :	212053
	PAGE :	page 1 of 12

# Calibration report

## Second Surface Reference mirror number OMT-212053-01

Direct reflectance at 8° incidence  
in the wavelength range 250 nm – 2500 nm.

**Visiting address:**  
 High Tech Campus 9  
 5656AE Eindhoven  
 The Netherlands

**Correspondence:**  
 P.O.Box 775  
 5600AT Eindhoven  
 The Netherlands

Tel: +31 40 85 19 260  
 Fax: +31 40 85 19 269  
 info@omtsolutions.com  
 www.omtsolutions.com

**Project nr:** 212053

**Customer:**

Material Lab | Abu Dhabi | Dubai  
 P.O Box 114717 , Dubai - United Arab Emirates

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<b>OMT Solutions BV</b> <i>Optical Measurements and Testing</i> <i>Materials for optical applications</i> <i>Thin Film Analysis</i>	DOC. NO.	: REP-212053-01
	ISSUE	: 1
	DATE	: 27/03/2013
	AUTHOR	: M.M.A.L. Dominicus – van den Acker
	PROJ. NO.	: 212053
	PAGE	: page 2 of 12

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<b>OMT Solutions BV</b> <i>Optical Measurements and Testing</i> <i>Materials for optical applications</i> <i>Thin Film Analysis</i>	DOC. NO. :	REP-212053-01
	ISSUE :	1
	DATE :	27/03/2013
	AUTHOR :	M.M.A.L. Dominicus – van den Acker
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## 1. Introduction

### 1.1 Applicable documents

- AD1 ORD-212053-05
- AD2 Guide to the Expression of Uncertainty in Measurement, ISBN 92-67-10188-9, 1st Ed. ISO, Geneva, Switzerland (1993).
- AD3 Mielenz, K.D. and Eckerle, K.L., Spectrophotometer at the National Physical Laboratory, J. Res. Of the National Bureau of Standards – A. Physics and Chemistry, Vol. 76A, 1972.
- AD4 Nijnatten, P.A. van, Calibration of neutral density glass filters to produce transmittance standards, 5th ESG Conference “Glass Science and Technology for the 21st Century”, Prague, 1999. AD3

### 1.2 Details

OMT Solutions BV has manufactured a series of second surface reference mirrors for UV/VIS/NIR reflectance. The design of these mirrors is shown in Fig. 2.1 below. The mirror coating is a Metal-dielectric multi-layer design optimised for stability and maximum reflectance in the UV/Vis/NIR range 200 nm – 2,500 nm. The coating is deposited on the back of the protecting front plate that consists of 2 mm ultrapure quartz. A soda-lime glass plate is glued to the back for protection.

Before calibration, the mirror was cleaned with chemically pure isopropyl alcohol. The mirror was calibrated at the angle of incidence of 8°.

Serial number of the mirror : OMT-212053-01

Dimensions of the mirror : 50 mm x 50 mm x 5 mm

Date of the calibration : 4 February 2013

Calibration performed by : M.M.A.L. Dominicus – van den Acker

This report gives a detailed description of the calibration procedure and evaluation of the calibration uncertainty.

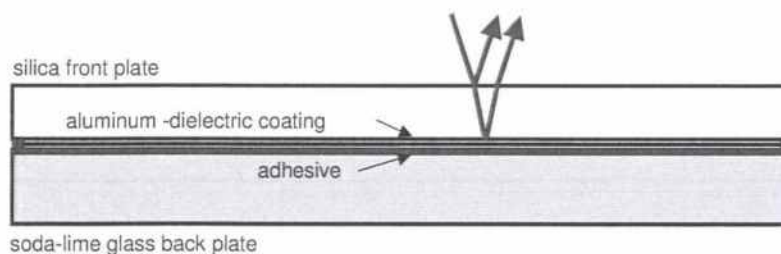


Figure 1.1 Design of the Second Surface Reference mirror issued by OMT solutions BV.

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## 2. Measurements

### 2.1 Equipment and conditions

Measurements are performed using a Perkin Elmer Lambda-900 UV/VIS/NIR spectrophotometer equipped with a collection sphere and the L631 200 Directional VW absolute reflectometer.

The following slit program was used:

- 5 nm slit in the wavelength range from 200 nm – 860.6 nm,
- “servo” in the wavelength range from 860.6 nm - 2,500 nm.

The sample temperature during the measurements was  $21 \pm 1$  °C.

### 2.2 Measurement principle

The measurement principle of the VW absolute reflectance accessory is based on a combination of two measurements (see Fig. 2.1 below). In the so-called V-mode the instrument beam is interacting with three mirrors (M1 - M3). In the so-called W-mode the beam additionally interacts twice with the sample. The ratio of the two scans produces the square of the sample reflectance. This method is an absolute one since a calibrated reference is not needed

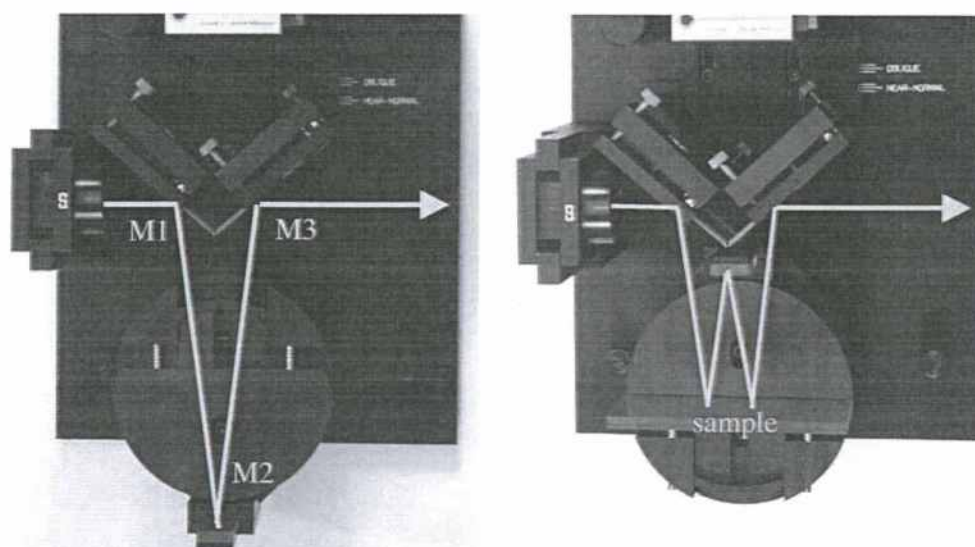


Figure 2.1 Top view of the VW set-up in the V-mode (left) and W-mode (right)

### 2.3 Measurement sequence

The following measurement sequence of 12 scans is applied (P and S refers to the polarization state):

1. 0% (stray light) measurement
2. 100% measurement, V-mode
3. sample measurement 1, W-mode
4. sample measurement 2, W-mode
5. 100% measurement, V-mode
6. sample measurement 3, W-mode
7. sample measurement 4 W-mode
8. 100% measurement, V-mode
9. sample measurement 5, W-mode
10. sample measurement 6, W-mode
11. 100% measurement, V-mode
12. 0% (stray light) measurement

Between sample measurements 1 and 2, 3 and 4, and 5 and 6 the sample is removed, repositioned and realigned.

### 2.4 Calculations

The measurement sequence results in the series  $M_{0,1}$ ,  $M_{V,1}$ ,  $M_{W,1}$ ,  $M_{W,2}$ ,  $M_{V,2}$ ,  $M_{W,3}$ ,  $M_{W,4}$ ,  $M_{V,3}$ ,  $M_{W,5}$ ,  $M_{W,6}$ ,  $M_{V,4}$ ,  $M_{0,2}$ , from which 6 reflectance values corresponding to each of the W-mode measurements are determined, according to:

$$R_i = \sqrt{\frac{2M_{W,i} - M_{0,1} - M_{0,2}}{M_{V,j} + M_{V,j+1} - M_{0,1} - M_{0,2}}}, \quad (1)$$

where  $j = 0.5(i + 1)$  for  $i = 1, 3, 5$  and  $j = 0.5i$  for  $i = 2, 4, 6$ .

The reflectance of the sample is determined by taking the average of these six values.

### 3. Uncertainty analysis

#### 3.1 Evaluation and Expression of Uncertainty

The procedures below are based on AD2.

The following measurement equation is valid for the reflection at near-normal incidence (8°) and given polarisation of an unknown sample:

$$R = \sqrt{f} \cdot \langle R \rangle + \Delta_{NL} + \Delta_{WL} + \Delta_A + \Delta_P + \Delta_{NU} \quad (2)$$

in which

$f$  is a factor that accounts for differences in alignment between V and W mode

$\langle R \rangle$  is the average of the measured reflectance values,

$\Delta_{NL}$  is a contribution that accounts for detector non-linearity

$\Delta_{WL}$  is a contribution that accounts for a systematic deviation in the wavelength

$\Delta_A$  is a contribution that accounts for a systematic deviation in the angle of incidence

$\Delta_P$  is a contribution that accounts for a systematic deviation in the polarisation

$\Delta_{NU}$  is a contribution that accounts for a systematic deviation due to sample non-uniformity

#### 3.2 Misalignment

The alignment factor  $f$  in Eq.(2) has a value of one with a standard uncertainty  $u_f < 0.001$  (conservative value based on experience). The uncertainty in the reflectance due to misalignment is proportional to  $u_f$  according to

$$u_M = \frac{1}{2} \langle R \rangle^2 u_f \quad (3)$$

#### 3.3 Standard uncertainty in the reflectance

The average reflectance values are estimated from 6 independent observations  $R_i$  according to Eq.(1). The standard uncertainty associated with these observations are the estimated standard deviations (of the mean) according to:

$$u_R = 1.11 \cdot \sqrt{\frac{1}{5} \sum_{i=1,3,5} \frac{(R_i - \langle R \rangle)^2}{6}} \quad (4)$$

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In which the factor 1.11 is the Student-t factor for 5 degrees of freedom and a 68.27% confidence level (1 sigma).

### 3.4 Detector non-linearity

The detector non-linearity produces a systematic uncertainty component that in principle can be corrected (see AD3 and AD4). This requires a thorough investigation of the instrument in use.

Our research (see AD4) has shown that, when a measurement is made with a background correction (values between 0% and 100%), the non-linearity error of the Lambda 900 approximates the function

$$\Delta_{NL} = C(1 - M)M \quad (5)$$

where M is the measurement value (between 0 and 1) and C a constant that is wavelength dependent. According to this equation, the non-linearity error is zero at 0% and 100% and has its maximum at M = 0.5 (50%). The constant C in (6) can be determined using the Double Aperture Method as described in AD4.

If we don't make a non-linearity correction, we chose  $\Delta_{NL} = 0$  in equation (3). The standard uncertainty associated with  $\Delta_{NL}$  is then

$$u_{NL} = \frac{1}{4}C(1 - R)R \quad (6)$$

We can obtain a safe estimate for C by using the limits of the photometric accuracy of the Lambda 900 according to specifications and experience. Using conservative values, we find:

In the UV/Vis range (photometric accuracy = 0.2%) → C = 0.008

In the NIR range (photometric accuracy = 0.3%) → C = 0.012

The factor  $\frac{1}{4}$  is a correction for the fact that we measure  $R^2$  and for the coverage factor of 2 that is assumed to be associated with the specified photometric accuracy:

Given the reflectance range in which the VW accessory operates, the non-linearity errors according to these specifications and Eq. (6), follow the curves shown in Fig. 3.1 below.

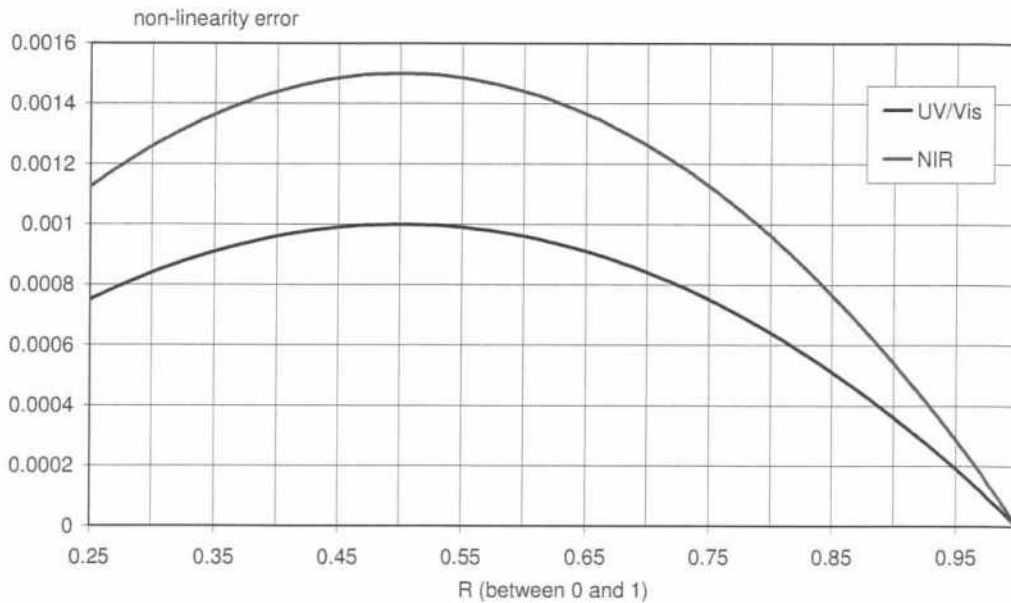


Figure 3.1 Worst-case detector nonlinearity (2 x standard uncertainty)

### 3.5 Wavelength uncertainty

The correction for a systematic deviation in the wavelength  $\Delta_{WL}$  is assumed to be zero with a standard uncertainty that can be estimated using wavelength standards.

Unless the measured spectrum is flat, the uncertainty in the wavelength will yield an uncertainty in the ordinate. Taking into account that we measure the square of the reflectance, the standard uncertainty due to this effect is given by:

$$u_{wL} = \frac{1}{2} \left| \frac{\partial R}{\partial \lambda} \right| u_{\lambda} \approx \frac{1}{2} \left| \frac{\Delta R}{\Delta \lambda} \right| u_{\lambda} \quad (7)$$

Typical values for the standard uncertainty in the wavelength scale of the Lambda 900 are:

- In the UV/Vis range →  $u_{\lambda} = 0.1 \text{ nm}$
- In the NIR range →  $u_{\lambda} = 0.15 \text{ nm}$

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### **3.6 Angular uncertainty**

The standard uncertainty due to the uncertainty in the angle of incidence is assumed to be negligible!

### **3.7 Uncertainty in the polarization**

The calibration has been performed with a Common Beam Depolarizer to scramble the polarization of the beam interacting with the sample. The standard uncertainty due to the residual polarization in the beam is assumed to be negligible!

### **3.8 Sample non-uniformity**

The sample non-uniformity is expressed in a standard uncertainty  $u_{NU}$  and is determined from a series of mirrors from the same batch and is set to 0.0007.

### **3.9 Combined standard uncertainty**

The combined standard uncertainty in the measured reflectance is obtained according to

$$u_C = \sqrt{(u_R)^2 + (u_M)^2 + (u_{NL})^2 + (u_{WL})^2 + (u_{NU})^2} \quad (9)$$

### **3.10 Expanded uncertainty**

The expanded uncertainty  $U$  provides an interval  $R-U$  to  $R+U$  about the result  $R$  within which the value of  $R$  can be asserted with a high level of confidence.

The expanded uncertainty is determined by multiplying the combined standard uncertainty  $u_C$  of Eq.(9) with a coverage factor  $k$  (for which commonly a value  $k=2$  is chosen).

## 4 Conclusion

### 4.1 Calibration results

The calibration results of the reflectance standard **OMT-212053-01** which has been calibrated in the wavelength range from 250 nm to 2,500 nm at an angle of incidence of 8° are shown in Figs. 4.1 and 4.2 below. A table of the Reflectance and Expanded Uncertainty (see 3.10) with a coverage factor  $k = 2$  is given in the appendix.

### 4.2 Using the calibrated mirror

The mirror is a primary reflectance standard, mainly intended as a reference mirror in UV/VIS/NIR reflectance measurements. The mirror can be cleaned, by wiping its front surface with a soft tissue and de-mineralised water or isopropyl alcohol.

Reflectance sample: OMT-212053-01, angle of incidence 8°

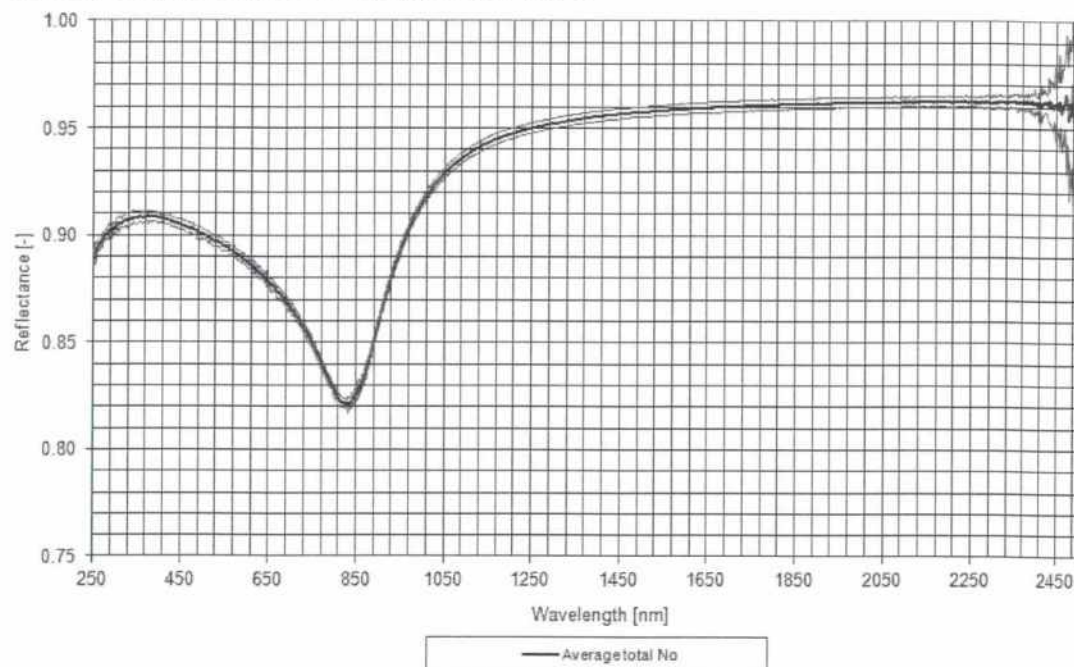


Figure 4.1 Near-normal (8°) Reflectance of the mirror OMT-212053-01



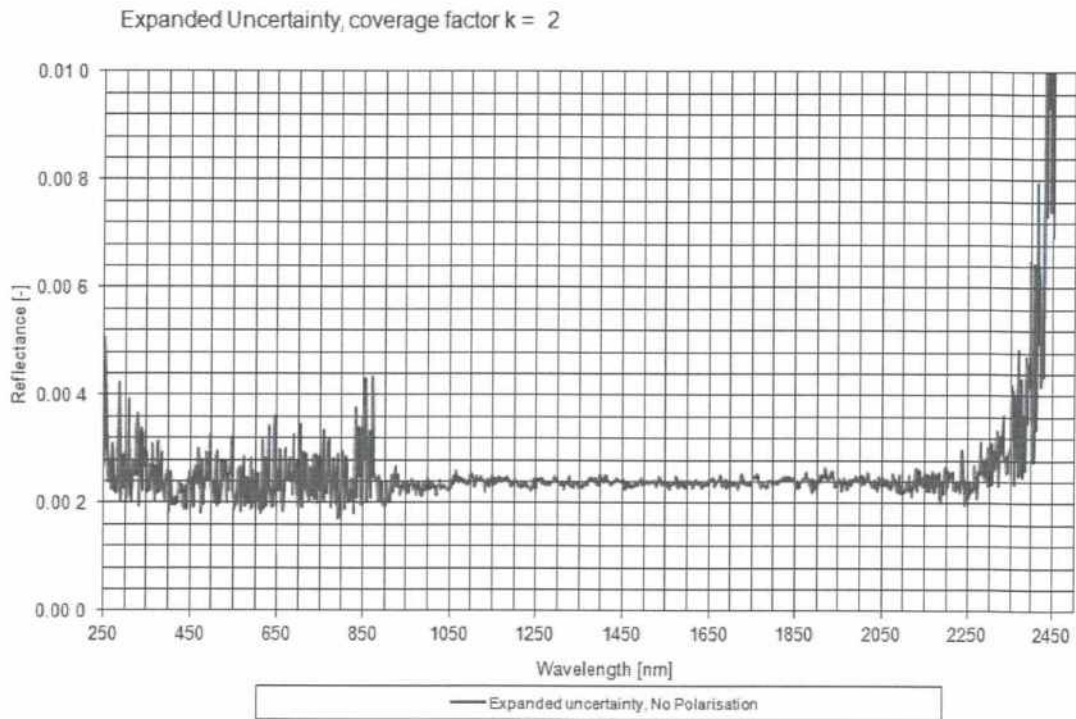



Figure 4.2 Standard uncertainty for mirror OMT-212053-01

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## 5 Authorization

	Name	Signature
Calibration performed by	M.M.A.L. Dominicus – van den Acker	
Authorized by	S.J.M. Timmermans	

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7: PICTURES





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