ماتيريال لاب
Material Lab

Material Lab

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

Tel.: +971 4 3405678

Fax: +971 4 3450677

Email: mld@eim.ae

Website: www.mlab.ae

Test Reports on Physical, Chemical and Thermal Properties of Bronya Façade

Client	:	Bronya
Address	:	P.O Box: 299195, SIT Tower, Silicon Oasis, Dubai, U.A.E
Telephone	:	+971 4 3363422
Fax	:	+971 4 3363422
Lab Project No.	:	P – 3004
Date	:	11-August-2015

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Table of Contents:

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1: INTRODUCTION

Introduction:

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

1. Solar Reflectance Index (SRI)
2. Checmical Resistance
3. Resistance to Water
4. Bond Strength on Metal Substrate

Instrumentation:

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

- ICP/OES
- GC / FID
- Pull Off Tester



Test Methods:

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

1.	Solar Reflectance Index (SRI)	ASTM E903 : 01
2.	Checmical Resistance	ASTM D543 - 95
3.	Resistance to Water	ASTM D543 - 95
4.	Bond Strength on Metal Substrate	ASTM D4541 - 95

Technical Details (provided by the sponsor):

Technical details of Bronya Façade are provided below:

"Bronya Facade is an extra-fine thermal insulation. This is the first in the world extra-fine ceramic thermal insulating material which can be applied by 1mm layer at a time and which has vapour permeability of high-quality facade paint. Extra-fine thermal insulation Bronya Facade has been developed especially for concrete surfaces. Due to high heat-reflective properties and reduced labour costs for coat application if compared to similar extra-fine thermal insulators at least by half, it will be the best solution for construction professional thermal insulation for you and your clients. Extra-fine thermal insulation Bronya Facade is an extra-fine liquid ceramic thermal insulating material which can be applied by 1 to 3mm layers at a time (which depends on application type) and which has vapour permeability of high-quality facade paint (0.03)."

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2: DETAILED TEST REPORTS

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2.1: SOLAR REFLECTANCE INDEX TEST REPORT

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ENAS Emirates National Accreditation System NAL 068 17025

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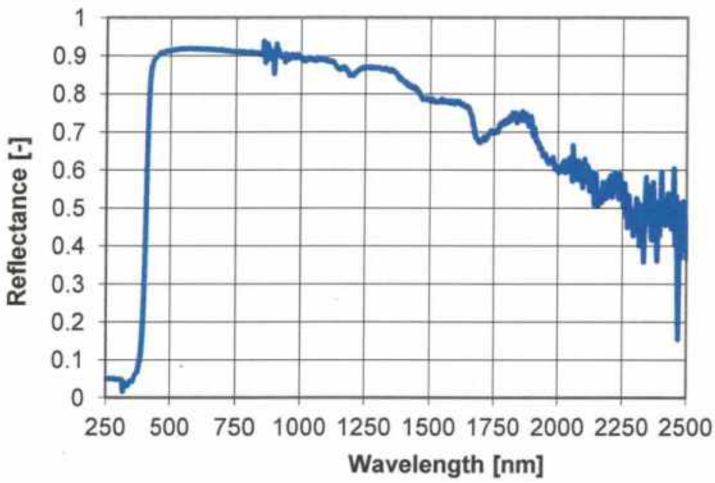
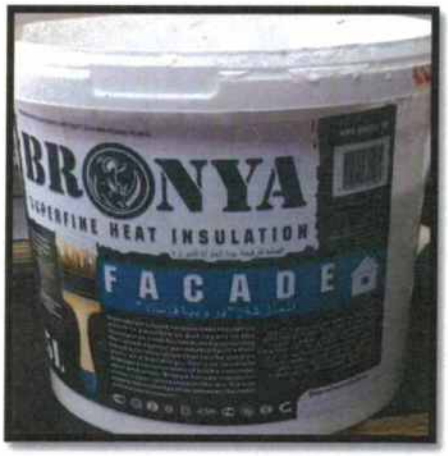
REPORT ON DETRMINATION OF SOLAR REFLECTIVE INDEX OF BRONYA FACADE

Client	: **Bronya**	Lab Ref No :	**434720**
Address	: Dubai U.A.E	Lab Project No :	**P-3004**
Contractor	: NP	Sample No :	**15-434720/1**
Consultant	: NP	Date of Sampling :	NP
Project	: Internal Quality Control	Date sample received :	25/07/2015
Sender No.	: NP	Date test started :	30/07/2015
Sample Description	: **Paint**	Date test completed :	31/07/2015
Sample Identification	: Bronya Facade	Report Date :	01/08/2015
Source of sample	: Client	Testing temperature :	22 °C
Sampled by	: Client	Relative Humidity :	55%
Sample brought in by	: Client	Tested by :	VL





Test Name	Unit	Test Method	Results
Solar Reflectance	%	ASTM E 903 :01	83
Corrected Normal Emissivity		EN 673:1997	0.91
SRI for low wind condition		ASTM E 1980:01	103.56
SRI for medium wind condition		ASTM E 1980:01	103.30
SRI for high wind condition		ASTM E 1980:01	103.01

Test method variation : Solar Reflectance was calculated by ASTM E 903 :01, Emissivity was calculated by EN 673: 1997

Remarks : Solar reflectance was calculated with the help of DBS having integrating sphere and special software from TNO Netherland.

: Corrected normal emissivity was calculated with the help of FTIR having special software from TNO Netherland for calculation of emissivity.

: SRI calculated based on Maximum Solar Reflectance.

Note:- This test is accredited by ENAS

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Authorized Signatory

Sohail Zafar
Laboratory Manager

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2.2: CHEMICAL RESISTANCE & RESISTANCE TO WATER TEST REPORT

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REPORT ON CHEMICAL RESISTANCE TO SOLVENT OF PAINT INSULATION

Client	: **BRONYA**		
Address	: P.O.Box Dubai, U.A.E		
Contractor	: NP	Sender's Id :	NP
Consultant	: NP	Client Ref No. :	Q/SZ/946-B/15
Project Name	: NP	Sampling Date :	25/07/2015
Sample Name	: **Bronya Façade**	Sampled by :	Client
Sample Size (kg)	: 5	Source of Sample :	Client
Sample Description	: Ultra Thin Insulation Coating		
Report No	: **434720 SN 1/3**	Date sample received :	25/07/2015
Lab Project No	: **P-3004**	Date test started :	28/07/2015
Lab Sample No	: **15-434720/6**	Date test completed :	10/08/2015
Tested by	: JD	Report Date :	11/08/2015
Specimen Size	: 0.6 mm (2 layer coat)		
Room testing temp.	: 25 ºC		
Relative humidity	: 55%		
Immersion Period	: 10 days		

Test Data:-

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

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

Authorized Signatory
002 سهيل ظفر Sohail Zafar Laboratory Manager

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Result relates only to the item tested.
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2.3: THERMAL TRANSMISSION REDUCTION TEST REPORT

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Tel.: +971 4 3405678

Fax: +971 4 3450677

Email: mld@eim.ae

Website: www.mlab.ae

Test Report on Thermal Transmission Reduction by the Application of Bronya Facade

Client	:	Bronya
Address	:	P.O Box: 299195, Silicon Oasis, Dubai, U.A.E
Telephone	:	+971 4 336 3422
Fax	:	+971 4 336 3422
Lab Project No.	:	P – 3004
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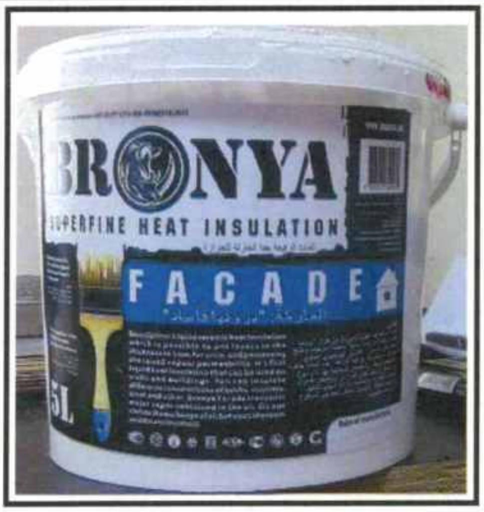

TABLE OF CONTENTS

Certificate Number: SNR 30362926/4/Q
ماتيريال لاب– دبي، صندوق بريد : ١١٤٧١٧ هاتف : ٣٤٠٥٦٧٨ ٤ ٩٧١+، فاكس: ٣٤٠٥٦٧٧ ٤ ٩٧١+
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1: INTRODUCTION:

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1.1: Test Method

Bronya commissioned Material Lab to determine the thermal efficiency of Bronya Facade. The purpose of this test is to establish a comparison for transmitting the heat through concrete walls

Two test chambers having an internal perimeter of 1.0m by1.0m were constructed using solid concrete blocks by Material Lab's skilled workers. The Testing product, Bronya Façade, was applied on the external surface of one of the chambers whereas the other one was left uncoated.

Both these chambers were constructed in an open compound under direct sunlight. A total of six thermocouples were assigned for each chamber, three for the monitoring of external surface temperature of the chamber and three for monitoring the internal surface temperature of the chamber.

One thermocouple was used to measure the ambient temperature. There is no artificially induced temperature control. The external environment is considered as the heating source. Temperature was monitored by the digital calibrated data acquisition system.

Figure 1: Data acquisition system used for temperature monitoring and data collection and compilation

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1.2: Test Chambers and Samples:

Test chambers were constructed by Material Lab while coating of Bronya Façade on one of the chambers was done by representatives of Bronya. In order to avoid the variation due to substrate, concrete blocks of same composition and thickness was selected.

All sides of chamber were sealed by sealant Hilti CP 606 acoustic mastic, to ensure there is no air gap which may allow the passage of hot air inside the chamber.

These chambers were separated by the distance of 40 cm and placed in a same line so that they should experience same ambient condition and experience the shade at the same time. Arrangement of placement of chambers is shown in figure 2.

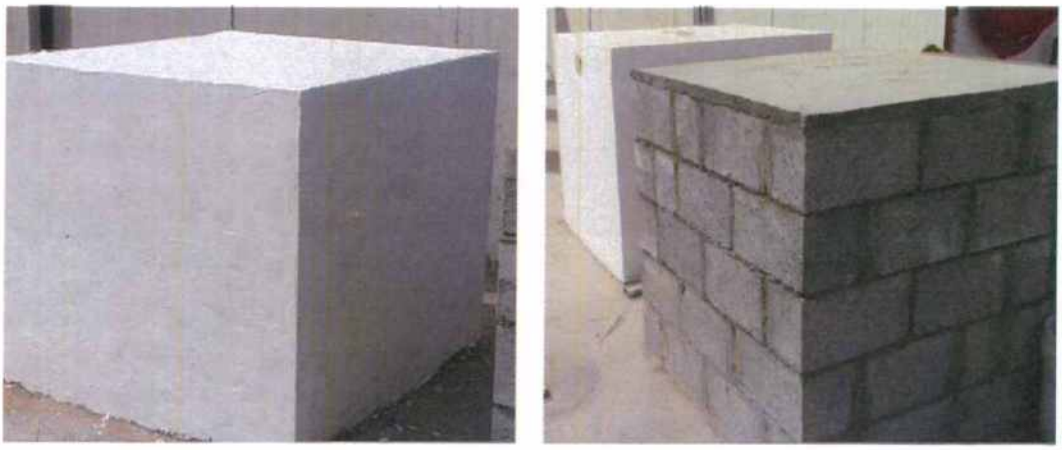

Figure 2: Placement of chambers

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1.3: Dimensions of Chamber

Dimensions of chamber are given below in figure 3:

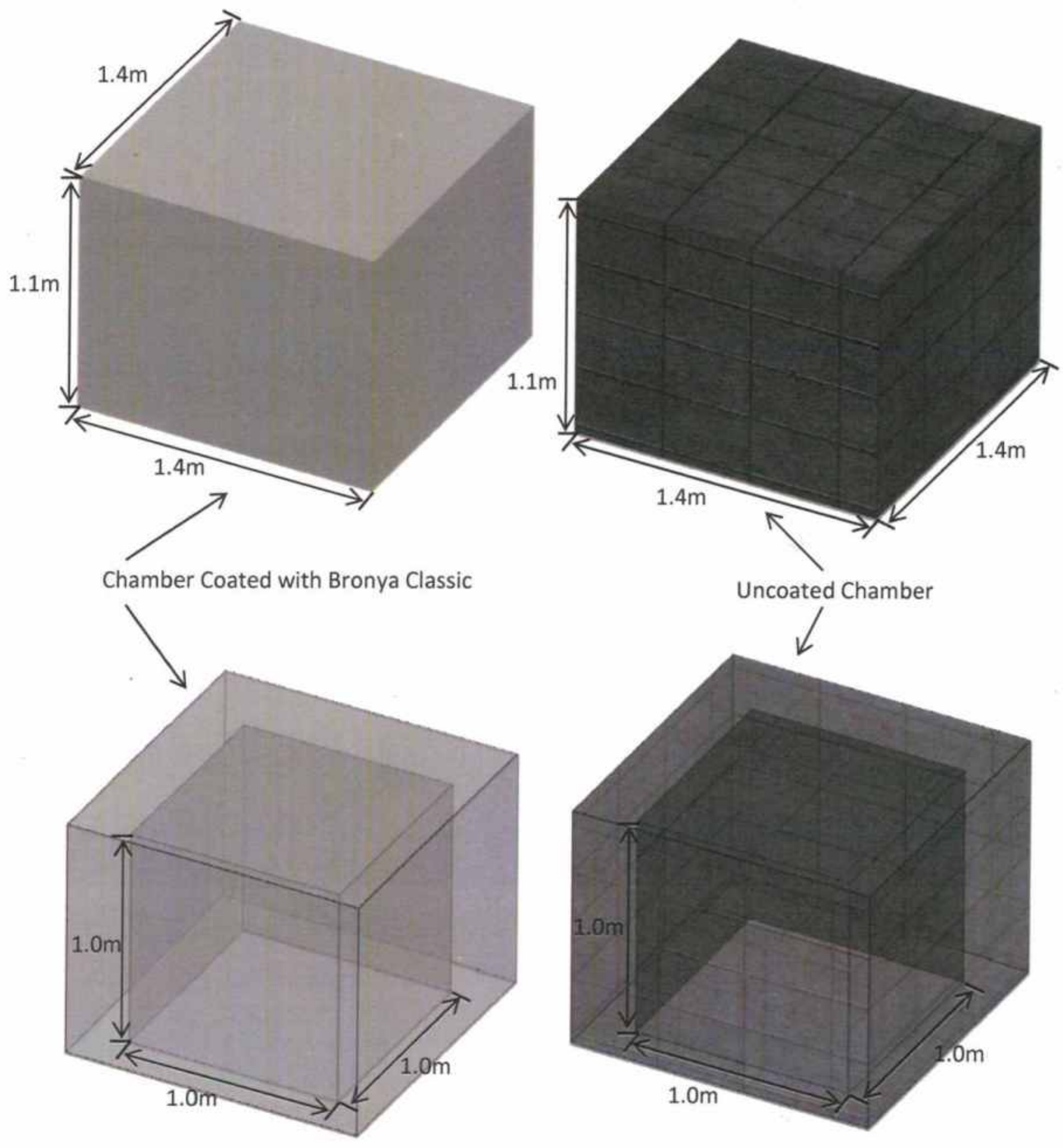

Figure 3: Dimension of chamber

Certificate Number: SNR 30362926/4/Q
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2: BACKGROUND AND LITERATURE REVIEW:

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As interest in climate change and the urban heat island effect grows, so too does the interest in the use of both vegetation and "cool" building materials to reduce the impact of both climate issues. As there is extensive research completed on the topics of both Urban Heat Island and Cool Roof products, this literature review is separated for ease of understanding.

Urban Heat Island The urban heat island (UHI) effect refers to the phenomenon of a metropolitan or built up area which is significantly warmer than its surrounding areas. In some cases, it causes average urban daytime air temperatures of typically 5.6°Chigher than the surrounding rural areas in summer (Akbari, Menon & Rosenfeld 2009).

The urban heat island effect can be detected throughout the year, but it is of particular public policy concern during the summer, because higher surface air temperature is associated with increases in electricity demand for air conditioning, air pollution, and heat stress-related mortality and illness (Rosenfeld et al. 1995; Nowak et al. 2000; Sailor et al. 2002; Hogrefe et al. 2004). According to the U.S. Centre for Disease Control and Prevention, more Americans over the past 20 years were killed by heat than by hurricanes, lightning, tornadoes, floods, and earthquakes combined.

There is currently available a number of products that can be applied to a variety of new and existing roof types to reduce primarily heat gain (reflection) through the surface of the roof and also in some cases to improve heat lost to the atmosphere (emissivity). These products vary widely in their application approach and performance.

A cool wall or roof is one that reflects the sun's heat and emits absorbed radiation back into the atmosphere at a higher rate than standard materials. Cool roof/walls performance may be achieved with additives to the base material, or by applying a CRP/CRW. These types of roofs/walls literally stay cooler, thus reducing the amount of heat held and transferred to the building below, keeping the building a cooler and more constant temperature.

A simple analogy is putting your hand on a white piece of metal out in the sun or a black piece of metal, or feeling warmer in a black jumper compared to a white jumper. And there are times when it is desirable to absorb more heat which happens most of the time in western cold countries.

It is important to note that with modern technology, CRP's/CWPs need not be white only . There are many CRP products which use darker-coloured pigments that have increased reflectivity in the near infrared (non-visible) portion of the solar spectrum. With these technologies there are roofs that come in a wide variety of colours and still maintain a high solar reflectance. It is generally accepted however that a darker roof will never be as reflective as a light coloured roof.

A building's cooling costs can effectively be reduced by application of suitable insulation on roof/ceilings and walls. A cost effective and easy means of insulation is through the use of special wall paint and coating having a high **Solar Reflective Index** or **SRI**.

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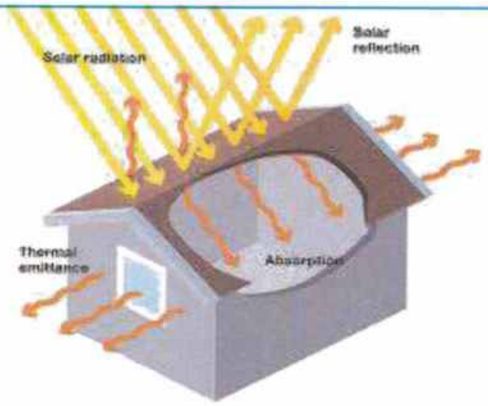

Figure 3: Large solar reflection and thermal emittance from material surface allows a room to remain cooler in hot climates

SRI of a constructed surface is a measure of the surface's ability to reflect solar heat. Calculation of SRI of a material takes into account two things; **emissivity** and **reflectance** of the material. Reflectance is the property of a material to reflect solar energy whereas emissivity is defined as the action of remitting absorbed solar energy from the surface of the material. Illustrated in figure 3 is a method for a building to stay cool by absorbing less heat. This can be achieved by using material with a high SRI, meaning that most of the heat rays are either reflected or emitted allowing very little heat to be conducted through into the building.

As shown in figure 4, standard black surface is defined to have an emissivity of 0.90 and reflectance of 0.05 together contributing to a SRI of 0. On the other hand standard white surface is defined to have an emissivity of 0.90 and reflectance of 0.80 together contributing to a SRI of 100.

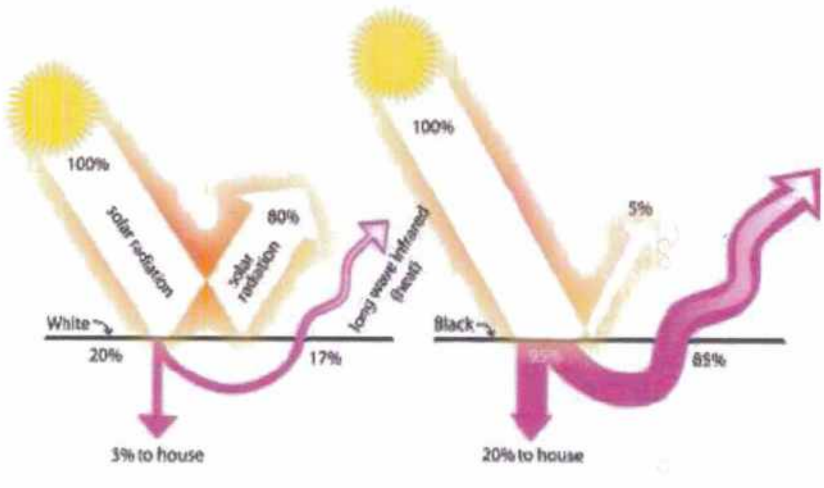

Figure 4: Illustration of reflection and emittance of heat from a white and black surface

Material Surface	Reflectance	Emittance	SRI
Black acrylic paint	0.05	0.9	0
New asphalt	0.05	0.9	0
Aged asphalt	0.1	0.9	6

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Aged concrete	0.2 to 0.3	0.9	19 to 32
New ordinary concrete	0.35 to 0.45	0.9	38 to 52
New white Portland cement concrete	0.7 to 0.8	0.9	86 to 100
White acrylic paint	0.8	0.9	100

Table 1: Example of material surfaces with their reflectance, emittance and SRI

Following are the important terminologies to understand the language of cool roof/wall properties

2.1: Solar Reflectance:

Solar Reflectance is the ability of a material to reflect solar radiation (light, infrared and UV). Typical values of solar reflectance are given below in table1.

Test name	Fresh Snow	Earth Average	Charcol
Solar Reflectance	0.9	0.3	0.04

Table 1

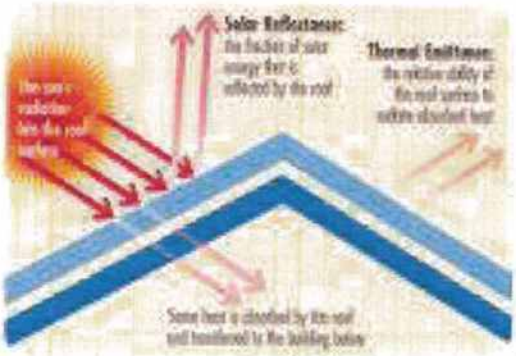

Figure 3: Figure illustrating solar reflectance

2.2: Thermal Emittance:

Thermal Emittance is a measure of the ability of the material to both absorb and re-radiate heat into the atmosphere.

Typical values of thermal emittance are given below in table 2.

Test name	Metal Roof	White Roof	Concrete
Emissivity	0.8	0.21	0.9

Table 2

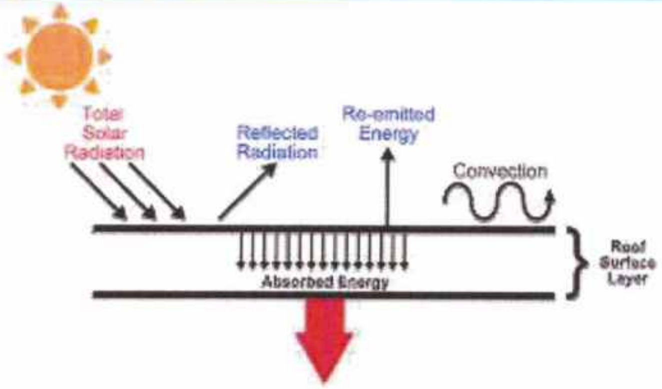

Figure 4: Figure illustrating thermal emittance

2.3: The Physics of Heat Transmission

Although it is not necessary to understand the physics of heat movement, it is useful to understand it in general terms. Heat transfer is the tendency of heat or energy to move from a warmer space to a cooler space until both spaces are the same temperature. Obviously the greater the difference in temperatures, the greater will be the heat flow. There are three types of heat transfer:

1. Via Conduction - This occurs when two objects are in direct contact, for example the air against a window or the soil against a foundation. In buildings, this is typically the most significant method of heat transfer. Conduction moves in all directions at the same time. The total heat transferred by conduction varies directly with time, area, and temperature difference, and inversely with the thickness of the material through which it passes.

2. Via Convection - This occurs within a fluid medium (e.g. air or water) and is the result of the warmer part of the fluid rising while the colder part sinks. Convection results in the entire fluid rapidly reaching the same temperature. The old saying that "heat rises" is really a misstatement that should say "warm air rises". Heat has no sense of direction, but warm air being lighter rises due to being displaced by colder air which has a greater pull of gravity. The heated air leaking out through door and window openings is an example of convection.

3. Via Radiation - This occurs between a warm object and a colder object when they are separated only by a medium which is transparent to infrared radiation. This is easiest to understand by just standing in the sun: while the sun is very far away, it is also very big and very hot while space and the atmosphere block very little of that incoming radiation. With smaller and much cooler objects, radiation is a much less significant source of heat transfer, although its affects can still easily be noticed. In a home, windows are transparent to some heat radiation (more about this in solar power), but the rest of the building is relatively opaque.

The primary heat loss is via conduction and convection. Let's discuss these further

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Certificate Number: SNR 30362926/4/Q
UKAS MANAGEMENT SYSTEMS
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2.4: Solar Reflectance Index:

The characteristics of cool roof properties have been combined into one single value known as the Solar Reflectance Index (SRI). The SRI value combines both the reflectivity value and emittance value as a measure of a coating's overall ability to reject solar heat. The calculation has a specific calculation that must be followed.

It is defined such that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100.

2.5: Benefits of a cool coating products

There are numerous benefits in having cool roofs/walls:

- Reducing your utility bills associated with air conditioning
- Due to lower use lower maintenance requirements for the air conditioning system
- Increasing occupant comfort and potential to avoid installing an air conditioner where not already installed
- Decreasing the size and prolonging the life of your air conditioning system
- Lowering roof maintenance costs and extending roof life, avoiding reroofing costs and reducing solid waste
- Assist your building in meeting building codes – Section J
- Mitigating your community's Urban Heat Island Effect
- Maintaining aesthetics with a roof that performs and looks good
- Increase ecological sustainability factor, or make your building "greener"

A cool wall/roof can significantly reduce your cooling energy costs and increase your comfort level by reducing temperature fluctuations inside your home. There are times where a cool roof is undesirable – such as a domestic dwelling that requires predominately heating. This type of building may have an increased heating need with the use of a CRP.

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Material Lab
P.O.BOX: 114717, Dubai, United Arab Emirates

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4: TABULATION OF SURFACE TEMPERATURE OF COATED AND UNCOATED CHAMBERS

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Material Lab
P.O.BOX: 114717, Dubai, United Arab Emirates

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Appendix-C
(Temperature Monitoring Readings)

Material Lab

Date & Time	Ambient	Coated Int. Temperature			Coated Ext. Temperature			Coated Avg. Int.	Coated Avg. Ext.	Coated ΔT	Uncoated Int. Temp.			Uncoated Ext. Temp.			Uncoated Avg. Int.	Uncoated Avg. Ext.	Uncoated ΔT
		C.I. TC-1	C.I. TC-2	C.I. TC-3	C.E. TC-4	C.E.TC-5	C.E. TC-6				U.I. TC-7	U.I. TC-8	U.I. TC-9	U.E. TC-10	U.E. TC-11	U.E. TC-12			
29/07/2015 8:00	38.0	37.0	36.0	37.0	39.0	38.0	38.0	36.7	38.3	1.7	40.0	40.0	39.0	42.0	41.0	40.0	39.7	41.0	1.3
29/07/2015 9:00	39.0	38.0	37.0	38.0	43.0	39.0	39.0	37.7	40.3	2.7	46.0	46.0	44.0	48.0	47.0	45.0	45.3	46.7	1.3
29/07/2015 10:00	41.0	39.0	39.0	39.0	47.0	45.0	44.0	39.0	45.3	6.3	49.0	48.0	46.0	53.0	51.0	50.0	47.7	51.3	3.7
29/07/2015 11:00	42.0	40.0	40.0	39.0	49.0	46.0	45.0	39.7	46.7	7.0	55.0	53.0	51.0	59.0	56.0	55.0	53.0	56.7	3.7
29/07/2015 12:00	44.0	41.0	41.0	39.0	50.0	46.0	46.0	40.3	47.3	7.0	58.0	56.0	54.0	60.0	59.0	59.0	56.0	59.3	3.3
29/07/2015 13:00	43.0	42.0	42.0	40.0	53.0	47.0	44.0	41.3	48.0	6.7	59.0	58.0	56.0	61.0	60.0	59.0	57.7	60.0	2.3
29/07/2015 14:00	43.0	44.0	44.0	41.0	53.0	48.0	44.0	43.0	48.3	5.3	60.0	57.0	56.0	62.0	60.0	59.0	57.7	60.3	2.7
29/07/2015 15:00	40.0	44.0	44.0	42.0	52.0	48.0	44.0	43.3	48.0	4.7	59.0	56.0	56.0	60.0	59.0	58.0	57.0	59.0	2.0
29/07/2015 16:00	40.0	45.0	44.0	42.0	49.0	47.0	43.0	43.7	46.3	2.7	58.0	55.0	53.0	59.0	58.0	56.0	55.3	57.7	2.3
29/07/2015 17:00	40.0	44.0	43.0	41.0	47.0	45.0	42.0	42.7	44.7	2.0	53.0	50.0	49.0	57.0	56.0	54.0	50.7	55.7	5.0
30/07/2015 8:00	36.0	35.0	35.0	35.0	40.0	37.0	37.0	35.0	38.0	3.0	39.0	38.0	36.0	41.0	40.0	39.0	37.7	40.0	2.3
30/07/2015 9:00	38.0	36.0	36.0	36.0	43.0	38.0	38.0	36.0	39.7	3.7	45.0	44.0	42.0	47.0	46.0	44.0	43.7	45.7	2.0
30/07/2015 10:00	40.0	37.0	37.0	37.0	46.0	45.0	41.0	37.0	44.0	7.0	46.0	45.0	44.0	50.0	50.0	49.0	45.0	49.7	4.7
30/07/2015 11:00	40.0	40.0	39.0	40.0	51.0	46.0	45.0	39.7	47.3	7.7	54.0	51.0	50.0	59.0	57.0	56.0	51.7	57.3	5.7
30/07/2015 12:00	40.0	41.0	39.0	40.0	55.0	47.0	46.0	40.0	49.3	9.3	56.0	52.0	52.0	62.0	60.0	59.0	53.3	60.3	7.0
30/07/2015 13:00	41.0	42.0	40.0	41.0	48.0	46.0	45.0	41.0	46.3	5.3	59.0	54.0	53.0	62.0	59.0	59.0	55.3	60.0	4.7
30/07/2015 14:00	42.0	44.0	43.0	41.0	48.0	46.0	45.0	42.7	46.3	3.7	59.0	54.0	54.0	60.0	58.0	57.0	55.7	58.3	2.7
30/07/2015 15:00	41.0	45.0	44.0	42.0	48.0	46.0	44.0	43.7	46.0	2.3	59.0	54.0	53.0	59.0	56.0	56.0	55.3	57.0	1.7
30/07/2015 16:00	40.0	45.0	44.0	43.0	48.0	44.0	43.0	44.0	45.0	1.0	55.0	53.0	52.0	57.0	56.0	55.0	53.3	56.0	2.7
30/07/2015 17:00	41.0	45.0	43.0	42.0	46.0	43.0	43.0	43.3	44.0	0.7	52.0	50.0	48.0	53.0	51.0	50.0	50.0	51.3	1.3
31/07/2015 8:00	37.0	36.0	35.0	34.0	39.0	38.0	38.0	35.0	38.3	3.3	41.0	40.0	38.0	43.0	42.0	40.0	39.7	41.7	2.0
31/07/2015 9:00	39.0	38.0	37.0	37.0	44.0	40.0	39.0	37.3	41.0	3.7	44.0	43.0	41.0	47.0	45.0	42.0	42.7	44.7	2.0
31/07/2015 10:00	40.0	38.0	38.0	38.0	46.0	42.0	41.0	38.0	43.0	5.0	49.0	48.0	46.0	54.0	51.0	50.0	47.7	51.7	4.0
31/07/2015 11:00	39.0	40.0	39.0	38.0	46.0	44.0	43.0	39.0	44.3	5.3	53.0	52.0	50.0	57.0	55.0	54.0	51.7	55.3	3.7
31/07/2015 12:00	39.0	42.0	42.0	40.0	47.0	46.0	45.0	41.3	46.0	4.7	59.0	58.0	56.0	63.0	61.0	58.0	57.7	60.7	3.0
31/07/2015 13:00	40.0	43.0	42.0	41.0	48.0	47.0	45.0	42.0	46.7	4.7	59.0	58.0	57.0	62.0	61.0	59.0	58.0	60.7	2.7
31/07/2015 14:00	40.0	45.0	42.0	42.0	49.0	48.0	45.0	43.0	47.3	4.3	59.0	57.0	57.0	61.0	60.0	60.0	57.7	60.3	2.7
31/07/2015 15:00	41.0	46.0	43.0	43.0	49.0	47.0	44.0	44.0	46.7	2.7	58.0	56.0	56.0	59.0	59.0	58.0	56.7	58.7	2.0
31/07/2015 16:00	41.0	46.0	43.0	43.0	49.0	47.0	44.0	44.0	46.7	2.7	56.0	55.0	54.0	58.0	58.0	57.0	55.0	57.7	2.7
31/07/2015 17:00	40.0	46.0	42.0	42.0	46.0	44.0	44.0	43.3	44.7	1.3	50.0	48.0	46.0	54.0	56.0	54.0	48.0	54.7	6.7
01/08/2015 8:00	35.0	36.0	35.0	35.0	42.0	38.0	37.0	35.3	39.0	3.7	40.0	40.0	39.0	41.0	41.0	39.0	39.7	40.3	0.7

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Appendix-C
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Date & Time		Coated Int. Temperature			Coated Ext. Temperature			Coated Avg. Int.	Coated Avg. Ext.	Coated ΔT	Uncoated Int. Temp.			Uncoated Ext. Temp.			Uncoated Avg. Int.	Uncoated Avg. Ext.	Uncoated ΔT
	Ambient	C.I. TC-1	C.I. TC-2	C.I. TC-3	C.E. TC-4	C.E.TC-5	C.E. TC-6				U.I. TC-7	U.I. TC-8	U.I. TC-9	U.E. TC-10	U.E. TC-11	U.E. TC-12			
01/08/2015 9:00	37.0	37.0	36.0	36.0	45.0	40.0	40.0	36.3	41.7	5.3	46.0	45.0	45.0	50.0	49.0	47.0	45.3	48.7	3.3
01/08/2015 10:00	38.0	38.0	38.0	37.0	47.0	43.0	42.0	37.7	44.0	6.3	49.0	48.0	47.0	54.0	53.0	50.0	48.0	52.3	4.3
01/08/2015 11:00	40.0	39.0	39.0	38.0	46.0	44.0	42.0	38.7	44.0	5.3	53.0	50.0	50.0	57.0	55.0	54.0	51.0	55.3	4.3
01/08/2015 12:00	41.0	42.0	41.0	40.0	47.0	46.0	45.0	41.0	46.0	5.0	58.0	57.0	56.0	63.0	61.0	59.0	57.0	61.0	4.0
01/08/2015 13:00	40.0	44.0	44.0	41.0	49.0	49.0	45.0	43.0	47.7	4.7	61.0	60.0	58.0	64.0	62.0	61.0	59.7	62.3	2.7
01/08/2015 14:00	40.0	45.0	45.0	42.0	50.0	50.0	45.0	44.0	48.3	4.3	61.0	60.0	58.0	63.0	62.0	62.0	59.7	62.3	2.7
01/08/2015 15:00	39.0	46.0	46.0	43.0	51.0	49.0	45.0	45.0	48.3	3.3	60.0	60.0	58.0	62.0	61.0	60.0	59.3	61.0	1.7
01/08/2015 16:00	38.0	46.0	44.0	43.0	50.0	47.0	44.0	44.3	47.0	2.7	57.0	58.0	55.0	59.0	59.0	59.0	56.7	59.0	2.3
01/08/2015 17:00	37.0	45.0	44.0	43.0	49.0	47.0	44.0	44.0	46.7	2.7	52.0	53.0	52.0	56.0	54.0	53.0	52.3	54.3	2.0

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5: GRAPHICAL REPRESENTATIONS OF TABULATED DATA

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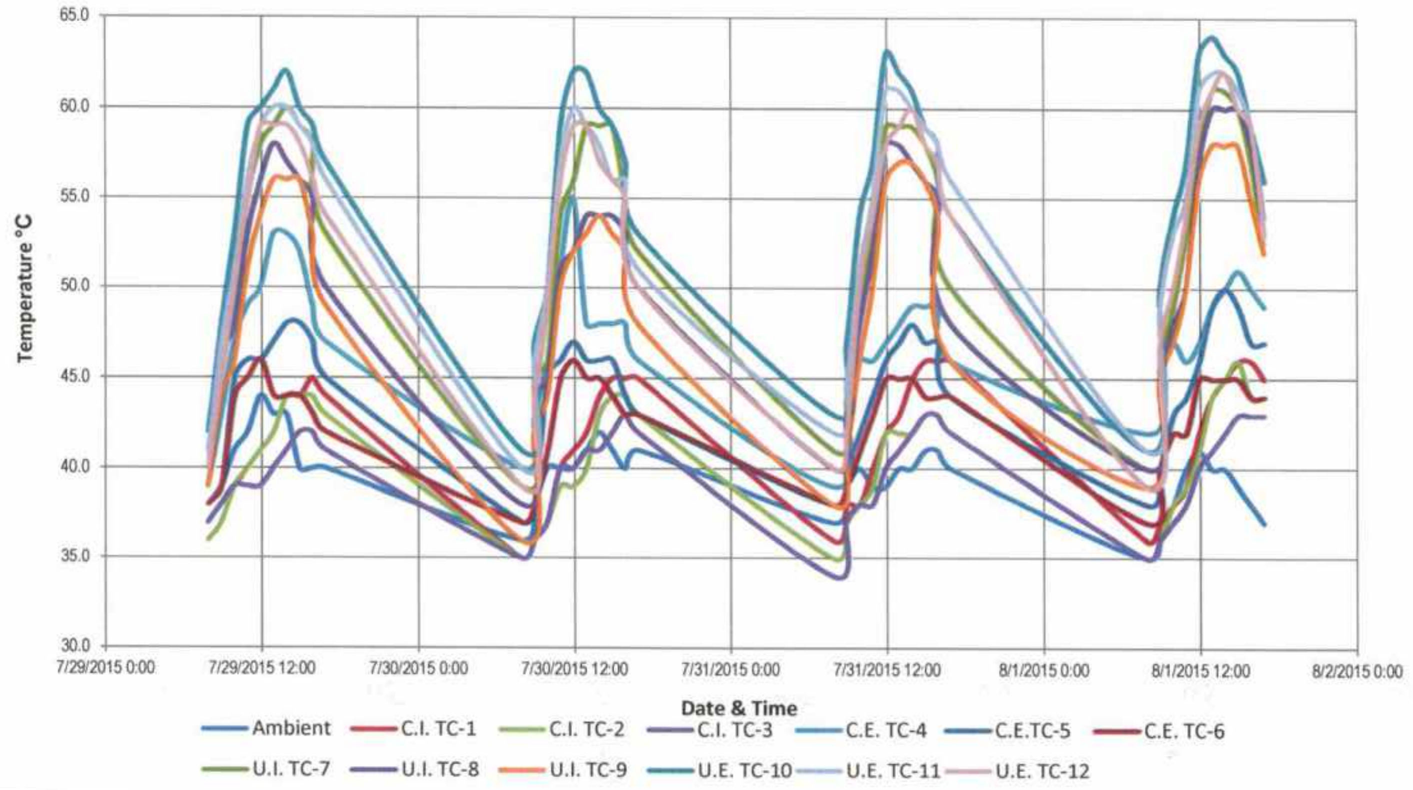
Graphical Representation of Temepratures of Coated & Uncoated External and Internal Surfaces



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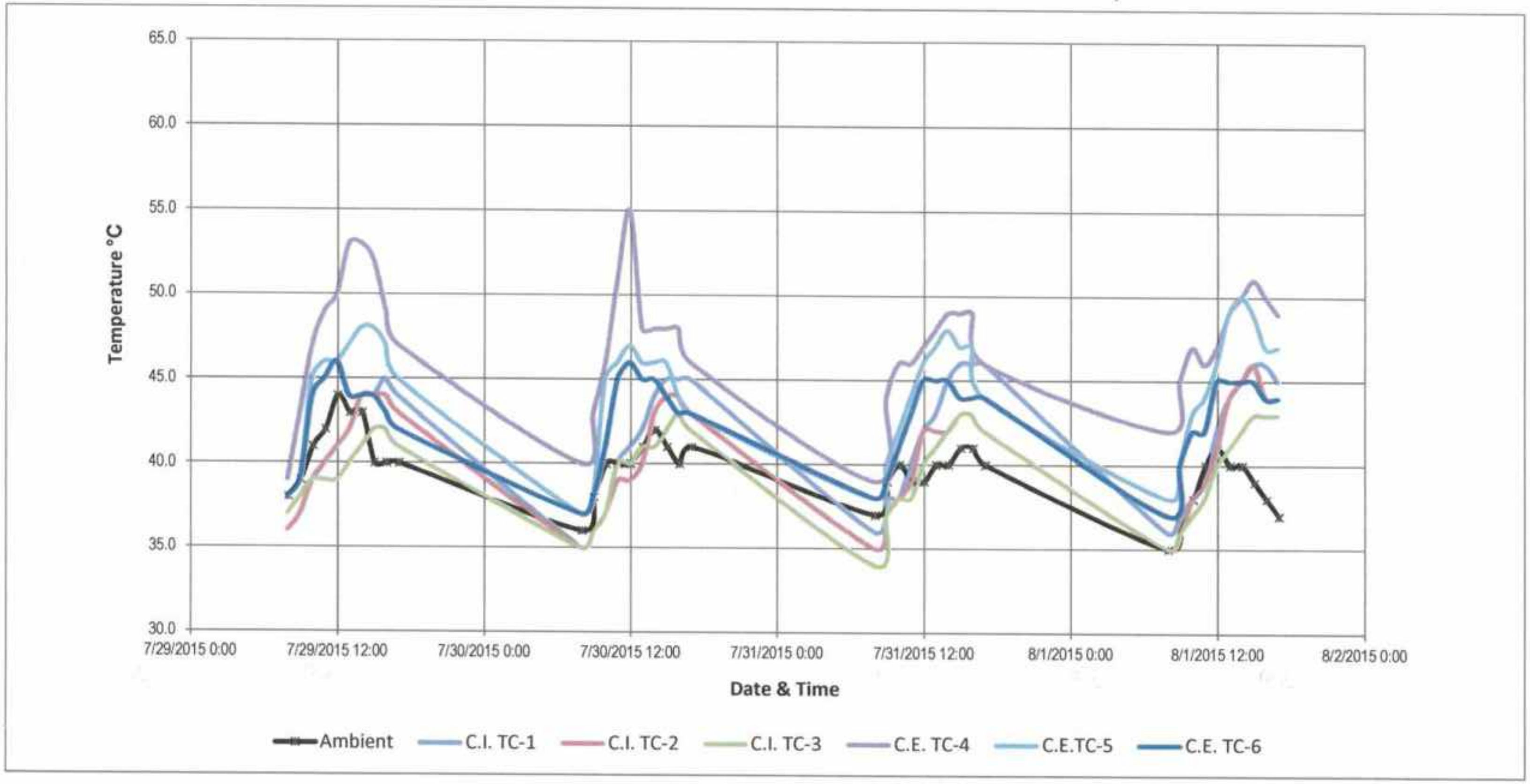
Graphical Representation of Temepratures of Coated Chamber External and Internal Surface



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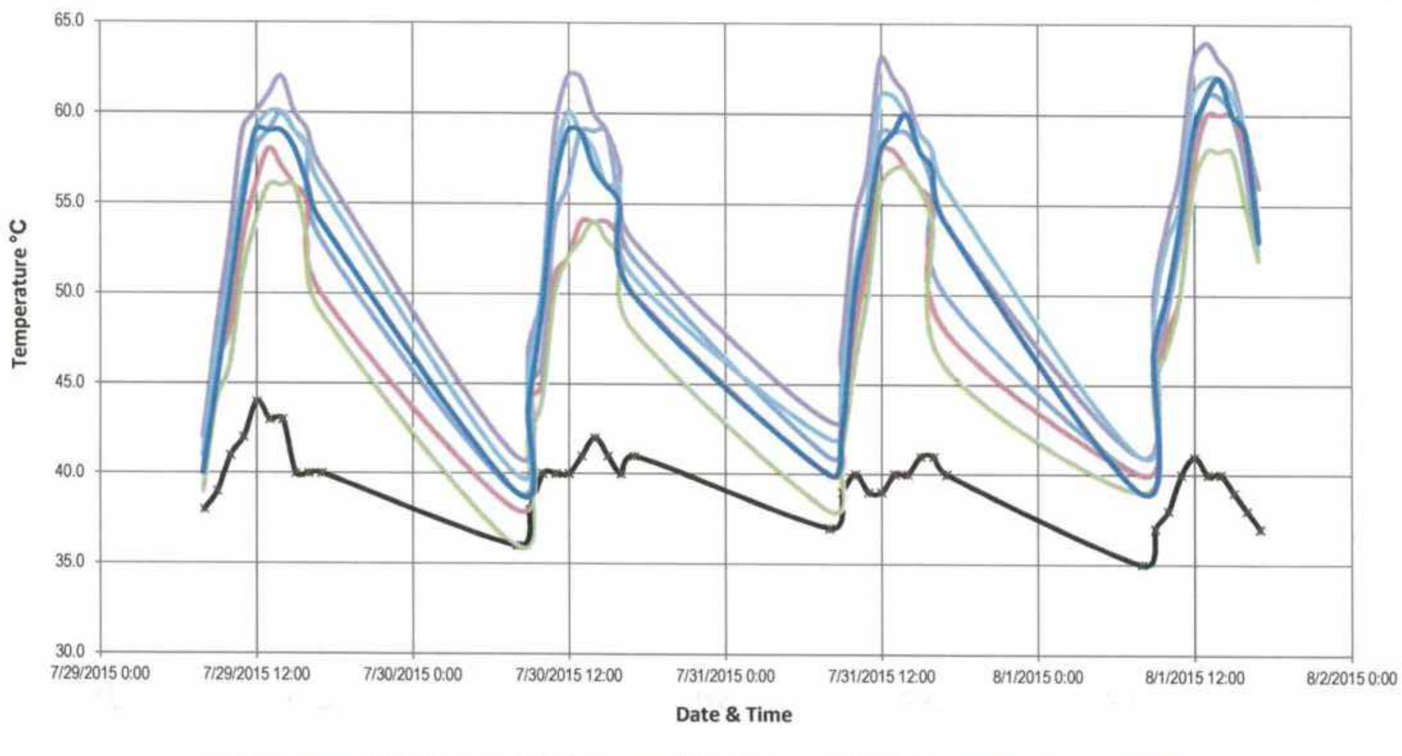
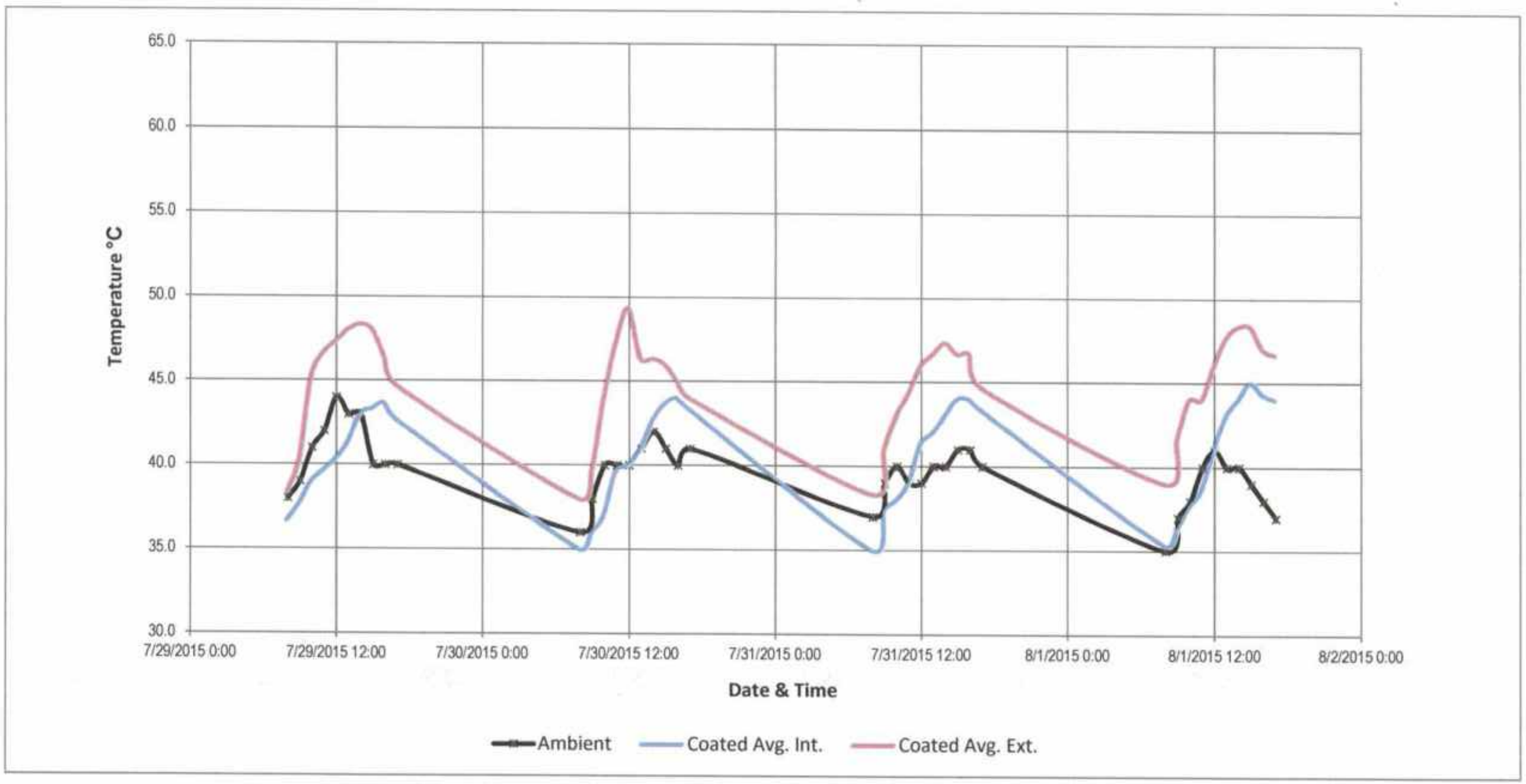
Graphical Representation of Temepratures of Uncoated Chamber External and Internal Surface



Graphical Representation of Average Temepratures of Uncoated Chamber External and Internal Surface



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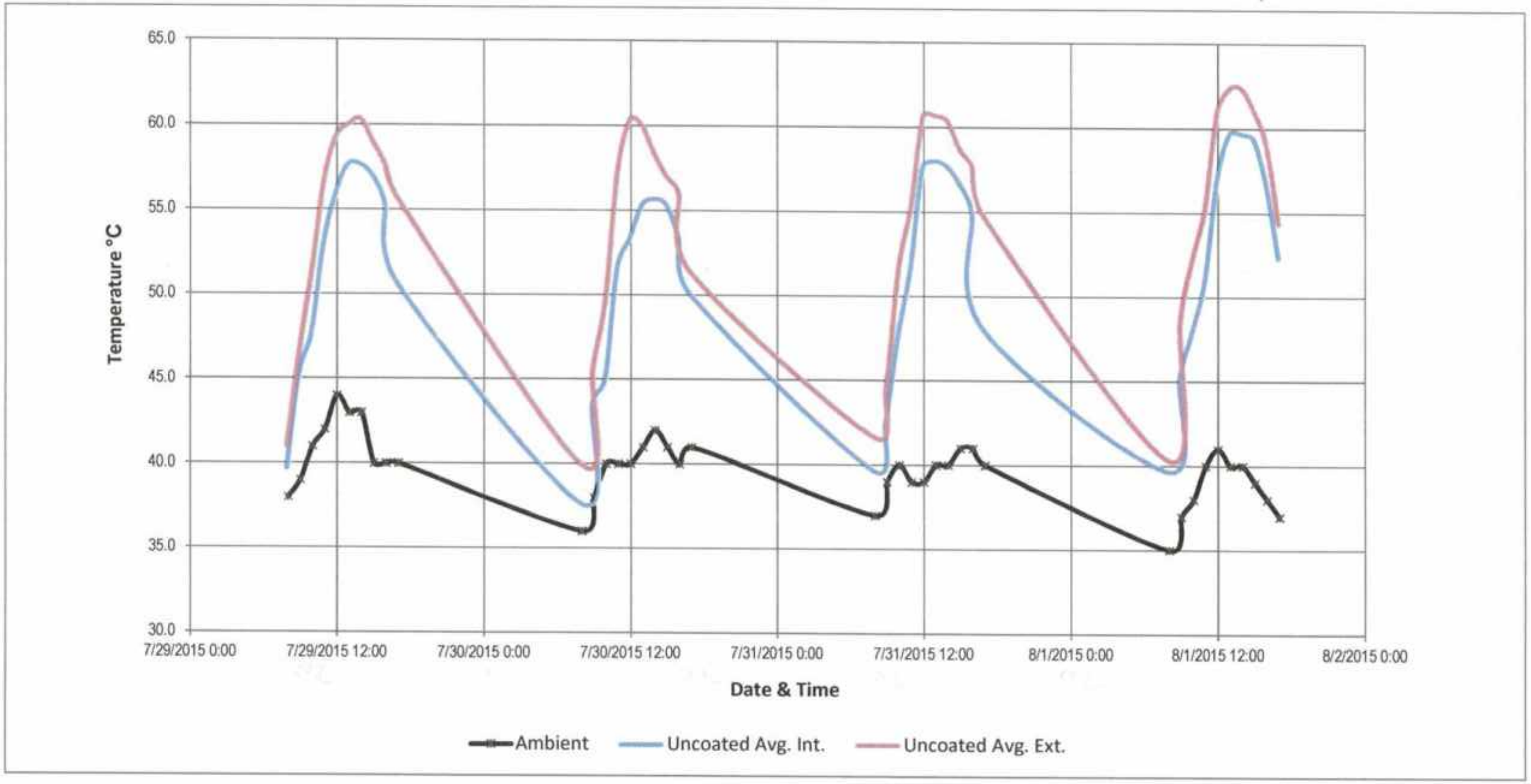
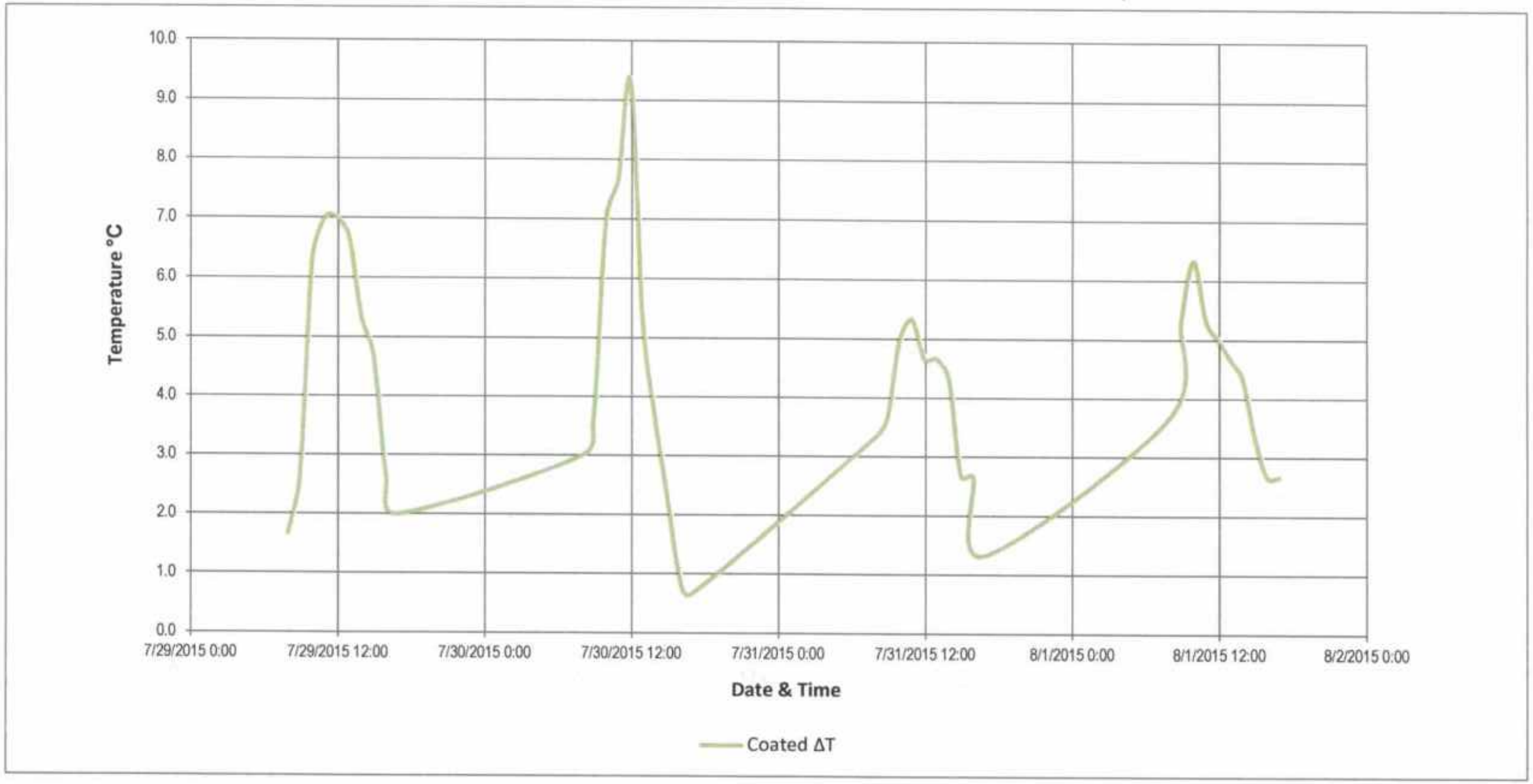
Graphical Representation of Average Temepratures of Uncoated Chamber External and Internal Surface



Graphical Representation of ΔT of Coated Chamber



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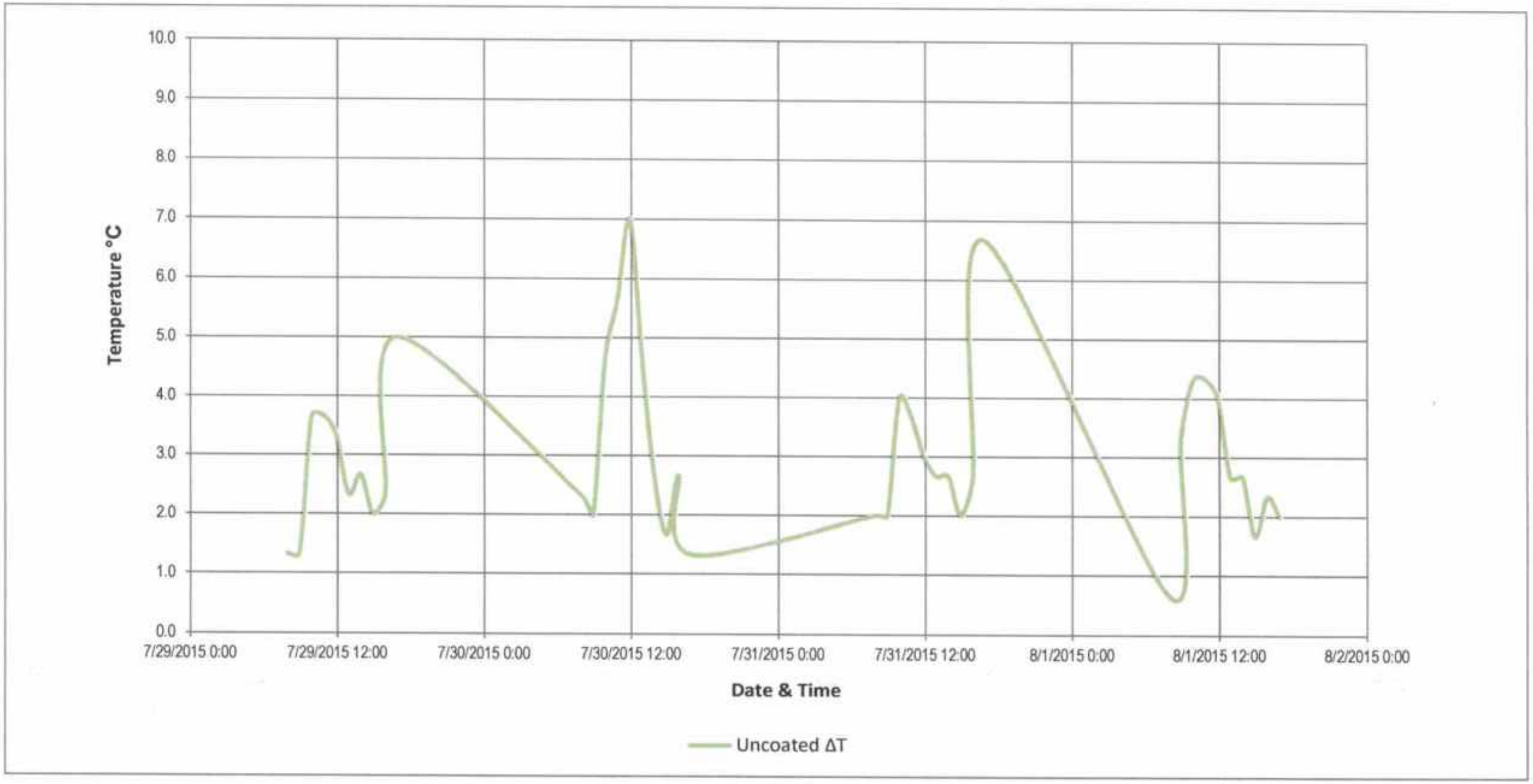
Graphical Representation of ΔT of Uncoated Chamber



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6: CONCLUSION

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Email: mld@eim.ae Website: www.mlab.ae

Temperature Data

Surface temperature is one of the most important parameter for energy conservation. Surface temperature of grey surface and Bronya Façade was measured for four days @ 1 hour interval. Data of surface temperature of the chamber and inside temperature is given in Appendix C

It has been observed that the surface of temperature of Bronya Façade was always less than the grey surface.

Energy Consumption Calculation

Energy consumption was determined by the following equation.

Q= $A * U(T2 - T1)$

In this analogy, it is considered that heating source is sun only. Other factors such as number of occupant, lighting factors, electrical home appliances are not included in these studies.

It was assumed that there are two walls. One wall is coated with Bronya Façade sample and other was bare wall (Grey Surface). Details of this hypothetical model are given below in table 6.

Sr. No	Description	Values
1	Area of Concrete Wall (m^2) "A"	1000
2	Inside Temperature ^{0}K "T1"	298
3	Extreme Surface Temperature of Bronya Classic	328
4	Extreme Surface Temperature of Grey Surface	336
6	U Value of Wall (W/m^2K)	3.45
7	Configuration of Wall	Solid Concrete Block

In order to determine the maximum performance of Bronya Façade, it was coated on the concrete of 200mm thick insulated wall.

The study covers the behavior of coating for the summer season only. This study does not cover the performance of coating in winter season.

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ماتيريال لاب
Material Lab
P.O.BOX: 114717, Dubai, United Arab Emirates

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Material Lab - Dubai, P.O. Box: 114717, Tel. + 971 4 3405678, Fax : + 971 4 3405677
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Energy Saving calculations

Energy consumption in KWH is given below in table 7

Sr.No	Sample Description	Energy Consumption for Cooling(KWH)
1	Bronya Façade	103.5
2	Grey Surface	131

In the above table Energy consumption values are given to cool the room for one hour @ 298 K which is equivalent to most common room temperature of 25^0C.

Total Energy Consumption In the Hot summer Season

In United Arab Emirates hot season starts from mid of April and it sustains till End of September. During this duration it is expected that ambient temperature will be more than 37 specifically from morning 1000hrs to 1600hrs. It can be extrapolated that there will be total 167 days or 1002 hours (considering six hot hours a day for 167 days) in which surface coating reflect the solar heat radiation and keeps the cool surface.

Total energy consumption to keep the room cool due to coating in summer season is given below in table 8

Sr. No	Sample Description	Energy Consumption for Cooling(KWH) for 167 hot days from 9am to 3 pm.
1	Bronya Façade	76397.5
2	Grey Surface	107163.9

Heat Gain:

Heat always travels from hot body to cold body. In summer outside surface temperature is always more than the inside surface temperature where occupants are living.

Sr.No	Sample Description	Heat Gain Per Day (Six Hot Hours) KWH
1	Bronya Façade	427.5
2	Grey concrete Surface	647.9

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Material Lab

Certificate Number: SNR 30362926/4/Q
ماتيريال لاب – دبي، صندوق بريد : ١١٤٧١٧ هاتف : ٩٧١٤٣٤٠٥٦٧٨+، فاكس :٩٧١٤٣٤٠٥٦٧٧+
ماتيريال لاب جلف لفحص التربة – أبوظبي : صندوق بريد :٦١٨٣١، هاتف : ٩٧١٢٥٥٠٣٠٤٠+، فاكس : ٩٧١٢٥٥٠٣٠٤١+
Material Lab - Dubai, P.O. Box: 114717, Tel. + 971 4 3405678, Fax : + 971 4 3405677
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

From the online literature it has been confirmed that cost of electricity is 28 fills for 1 KWH for residential while 38 fills for industrial. If the same above mentioned analogy considered then the total cost for the electricity consumption will be as given below in table 9

Sr. No	Sample Description	Total cost of electricity for Cooling(DHs) for 167 hot days from 9 am to3 pm.
1	Bronya Façade	29030.86
2	Grey concrete Surface	40722.2

Conclusion

From the above calculation it has been concluded that around 28.7% of electricity cost can be reduced by using Bronya Façade.

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Certificate Number: SNR 30362926/4/Q
ماتيريال لاب– دبي ، صندوق بريد : ١١٤٧١٧ هاتف : ٣٤٠٥٦٧٨ ٤ ٩٧١+، فاكس :٣٤٠٥٦٧٧ ٤ ٩٧١+
ماتيريال لاب جلف لفحص التربة – أبوظبي : صندوق بريد :٦١٨٣١، هاتف : ٥٥٠٣٠٤٠ ٢ ٩٧١+، فاكس : ٥٥٠٣٠٤١ ٢ ٩٧١+
Material Lab - Dubai, P.O. Box: 114717, Tel. + 971 4 3405678, Fax : + 971 4 3405677
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7: LIMITATIONS

Certificate Number: SNR 30362926/4/Q
ماتيريال لاب – دبي، صندوق بريد : ١١٤٧١٧ هاتف : ٣٤٠٥٦٧٨ ٤ ٩٧١+، فاكس :٣٤٠٥٦٧٧ ٤ ٩٧١+
ماتيريال لاب جلف لفحص التربة – أبوظبي : صندوق بريد :٦١٨٣١، هاتف : ٥٥٠٣٠٤٠ ٢ ٩٧١+، فاكس : ٥٥٠٣٠٤١ ٢ ٩٧١+
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It should be noted that this test was carried out during the summer period, in the month of July and August when temperatures exceed 40 °C regularly. Results obtained depict the samples behaviour during extremely hot weather. It is expected that the samples when subjected to the less intense heat experienced in the winter months shall yield different results with lower surface temperatures and lower differences between the chambers are predicted.

Results relate only to the specified construction of chamber. This test report does not constitute an approval or certification of the tested product by the testing laboratory or by the accrediting body overseeing laboratory's activities. The test was carried out using testing equipment that is property of the Material Lab, Dubai. This report shall not be reproduced except in full, without the written approval of the laboratory.

ص.ب ١١٤٧١٧، دبي، دولة الامارات العربية المتحدة
ماتيريال لاب
Material Lab
P.O.BOX. 114717, Dubai, United Arab Emirates

Tested & Prepared By	Checked & Verified By
Muhammad Zuhaib Saleem	Sohail Zafar Laboratory Manager

002 سهيل ظفر Sohail Zafar Laboratory Manager

Certificate Number: SNR 30362926/4/Q
ISO9001:2008
UKAS MANAGEMENT SYSTEMS
ماتيريال لاب- دبي ، صندوق بريد : ١١٤٧١٧ هاتف : ٣٤٠٥٦٧٨ ٤ ٩٧١+، فاكس :٣٤٠٥٦٧٧ ٤ ٩٧١+
ماتيريال لاب جلف لفحص التربة – أبوظبي : صندوق بريد :٦١٨٣١، هاتف : ٥٥٠٣٠٤٠ ٢ ٩٧١+، فاكس : ٥٥٠٣٠٤١ ٢ ٩٧١+
Material Lab - Dubai, P.O. Box: 114717, Tel. + 971 4 3405678, Fax : + 971 4 3405677
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Email: mld@eim.ae Website: www.mlab.ae

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2.4: BOND STRENGTH ON METAL SUBSTRATE TEST REPORT

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ماتيريال لاب
Material Lab
P.O.BOX: 114717, Dubai, United Arab Emirates

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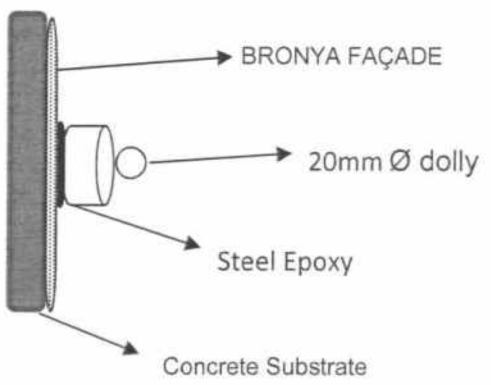
Material Lab

REPORT ON DETERMINATION OF PULL OFF STRENGTH OF BRONYA FACADE

Client	: **BRONYA**	Report No :	**436720 SN 1/1**
Address	: P.O.Box Dubai, U.A.E.	Lab Project No :	**P-3004**
Contractor	: NP	Lab. Sample No.:	15-436720/1-3
Consultant	: NP	Type of epoxy used to test:	Steel Epoxy
Project Name	: NP	Date test started :	28/07/2015
Project No.	: NP	Date test completed :	04/08/2015
Sample Description	: **BRONYA FAÇADE**	Report Date :	04/08/2015
Source of sample	: Client	Sender`s No :	NP
Substrate used	: Concrete Substrate	Tested by :	SH
Sampled by	: Client		
Direction of Test	: Vertical		

Test Data :

Lab Sample No.	Test Location	Area of Dolly (mm^2)	Maximum Load (N)	Pull Off Strength (N/mm^2)	Failure Mode
15-436720/1	Concrete Substrate	314	295	0.94	Cohesive failure within the BRONYA FAÇADE
15-436720/2		314	390	1.24	
15-436720/3		314	333	1.06	



Test Method	: **ASTM D 4541-95**
Test method variation	: Nil
Remarks	: Pull off test was carried out using a digital Positest Adhesion Tester.

Authorized Signatory

012 راجا كومار Raja Kumar Deputy Tech. Manager

ص.ب ١١٤٧١٧، دبي، دولة الامارات العربية المتحدة ماتيريال لاب Material Lab P.O.BOX: 114717, Dubai, United Arab Emirates

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3: SUMMARY OF ALL TESTS

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4: TECHNICAL DATA SHEET

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Material Lab

5: ACCREDITATION CERTIFICATES

United Arab Emirates

هـيئة الإمــارات للمواصـفات والمقاييـس
Emirates Authority For Standardization & Metrology

Certificate of Accreditation

Material Lab (NAL-68) ماتيريال لاب

(Al Quoz– Dubai, UAE) القوز –دبي- الامارات العربية المتحدة

حاصل على الاعتماد في مجال "فحص المواد الانشائية وفق الفحوصات المذكورة في وثيقة المجال المرفقة" وفقا للمتطلبات الدولية: ISO/IEC 17025 ¹

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

Accredited On	**2014/06/12**	تاريخ منح الاعتماد
Expires On	**2017/06/11**	تاريخ الانتهاء

الدكتور / راشد أحمد بن فهد
وزير البيئة والمياه
رئيس مجلس إدارة هيئة الإمارات للمواصفات والمقاييس

Emirates National Accreditation System

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 وفقا 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 واعادة الاصدار حتى تاريخ الانتهاء المدون اعلاه شريطة استمرار الجهة المذكورة اعلاه في تطبيق متطلبات المواصفات والادلة سالفة الذكر، وتتحمل الجهة مسؤولية الشهادات الصادرة عنها، وتخضع مجالات الاعتماد المذكورة في وثيقة المجال المرفقة لعمليات متابعة لاحقة من قبل نظام الاعتماد الوطني.

ص.ب ٤٨٦٦٦ دبي، الإمارات العربية المتحدة — P.O.Box 48666, Dubai - United Arab Emirates — Tel.: +971 4 2944434 هاتف — Fax: +971 4 2944428 فاكس
ص.ب 2166 أبوظبي، الإمارات العربية المتحدة — P.O.Box 2166, Abu Dhabi - United Arab Emirates — Tel.: +971 2 4032700 هاتف — Fax: +971 2 6715999 فاكس
600-565554
esma.gov.ae

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

Program Manager's signature

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Fax: +971 2 6715999 P.O.Box 2166, Abu Dhabi - United Arab Emirates
600-565554
esma.gov.ae

SNR CERTIFICATION

SNR CERTIFICATION

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
Registration House, 22b Church Street,
Rushden, Northamptonshire,
NN10 9YT, UK
Tel: +44 (0) 1933 381859
Email: info@snregistrars.com
Web: www.snregistrars.com
Company number: 07659067

Certificate Number: SNR 30362926/4/Q

MEMBER OF MULTILATERAL RECOGNITION ARRANGEMENT IAF

SNR CERTIFICATION ISO9001:2008

Member of SN Registrars (Holdings) Ltd

UKAS MANAGEMENT SYSTEMS 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

ماتيريال لاب
Material Lab

6: CALIBRATION CERTIFICATES

DANWAY
CALIBRATION & MEASUREMENTS LAB
Al Quoz Industrial Area #3, Plot No: 368-303
P.O. Box: 50048, Dubai - U.A.E.
Tel.: 00971 4 3473700 Fax: 00971 4 3473232

مختبر دانوي للاوزاز والمقاييس
Website : www.danway.ae
E-mail: lab@danwayirs.com

LB-023-CAL

DL-31

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 DCML/T-22*	*2013085668*
Serial No: of readout :	*150501100*				
Sensor used	*"K" type thermocouple wire*		**Environmental conditions**		**Calibrated by**
Asset No :	*DL-31*		*Temperature °C*	*Humidity %*	*Vahid*
Ranges : in °C	*-200 to 1370*		22.7	35	
Readability :	*0.1°C upto 200°C then 1°C*		**CONDITION** *: The EUC is in working order when received for calibration*		
Location	*Danway Lab, Al Quoz Ind. area # 3, Plot # 368-303*				

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 recommentation 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.

DAC LB-023-CAL

DANWAY
CALIBRATION & MEASUREMENTS LAB

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

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

UTM-2

CERTIFICATE OF CALIBRATION

Certificate No.	BDH/2014/3771/01	Page	1	of	2

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		Calibration Conditions	
Name of Instrument	Universal Testing Machine	Date of calibration	14/12/2014
Type	Digital	Recommended Due Date	13/12/2015
Make	Tinius Olsen	Temperature	23 ± 5 °C
Model	H25KT	Humidity	50 ± 15 %
Machine Capacity	25 kN	Location	Lab
Sr. No	H25KT-0084	Calibrated by	Gene & Prashant
ID No	-NA-	Condition on receipt	Good
Load cell Capacity	-NA-	Date of receipt	14/12/2014
Load cell Sr. No	-NA-	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 dtd1.11.14. 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)

ص.ب: ٢٨٦٣٧، دبي – ا.ع.م.، الطابق الأرضي، بناية البندري، شارع١٣، أم رمول المنطقة الصناعية، الراشدية
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

BDH
VWR INTERNATIONAL
ISO 9001:2008 CERTIFIED TÜV NORD

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

CALIBRATION RESULTS

Load cell used	Load N	Std. Rdg.	Observed Readings 0 °	120 °	240 °	Mean	% Rel. Accuracy Error	% Rel. Repeatability Error	% Exp. Uncertainty
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)

- This report refers to the item calibrated at customers site & the results are valid at the time of and under the conditions of measurement only.
- This report may not be reproduced, except in full without prior permission of BDH Laboratories.
- 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 measurments 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.

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

BDH
VWR INTERNATIONAL
ISO 9001:2008 CERTIFIED TÜV NORD

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. 4

CALIBRATION RESULTS

Load cell used	Load N	Std. Rdg.	Observed Readings 0 °	120 °	240 °	Mean	% Rel. Accuracy Error	% Rel. Repeatability Error	% Exp. Uncertainty
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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CALIBRATION RESULTS

Load cell used	Load N	Std. Rdg.	Observed Readings 0 °	120 °	240 °	Mean	% Rel. Accuracy Error	% Rel. Repeatability Error	% Exp. Uncertainty
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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Certificate of Analysis

Certipur® Certified Reference Material

Producer:	Merck KGaA, Frankfurter Str. 250, 64293 Darmstadt, Germany.
Description of CRM:	**ICP multi-element standard solution IV**
Ord. No.:	1.11355.0100
Lot No.:	HC379062
Composition:	23 elements in HNO_3 Suprapur® 6.5%
Density:	The density of the standard solution is 1.090 g/cm^3 at 20°C.
Method of Analysis:	Inductively coupled plasma optical emission spectrometry (ICP-OES).
Traceability:	This reference material has been measured applying high precision ICP-OES and is directly traceable to the corresponding **NIST SRM®** as mentioned on page 2. *NIST: National Institute of Standards and Technology, Gaithersburg, USA.*
Storage:	Store at +15°C to +25°C tightly closed in the original container.
Application and correct use:	This reference material is intended for use as **calibration standard** for atomic absorption spectrometry, spectrophotometry and other analytical techniques. Shake well before use and never pipet directly from the original container.
Date of release:	2013/03/11
Minimum shelf life:	2016/03/31

Merck KGaA · Frankfurter Straße 250, 64293 Darmstadt, Germany: +49 6151 72-0

EMD Millipore Corp. · 290 Concord Road, Billerica, MA 01821, USA: +1-781-533-6000

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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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DANWAY
CALIBRATION & MEASUREMENTS LAB
Al Quoz Industrial Area #3, Plot No: 368-303
P.O. Box: 50048, Dubai - U.A.E.
Tel.: 00971 4 3473700 Fax: 00971 4 3473232

مختبر دانوي
للاوزاز والمقاييس

Website : www.danway.ae
E-mail: lab@danwayirs.com

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 recommentation 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

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

Kr

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

Content

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.

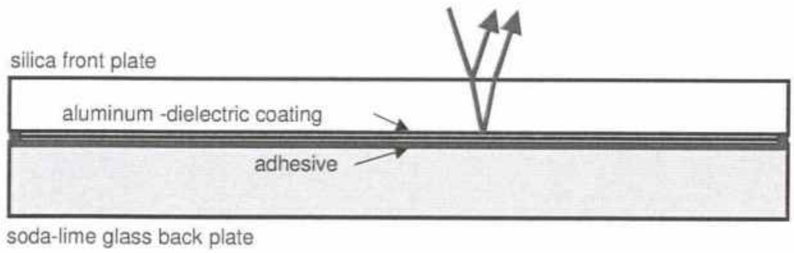


Figure 1.1 Design of the Second Surface Reference mirror issued by OMT solutions BV.

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

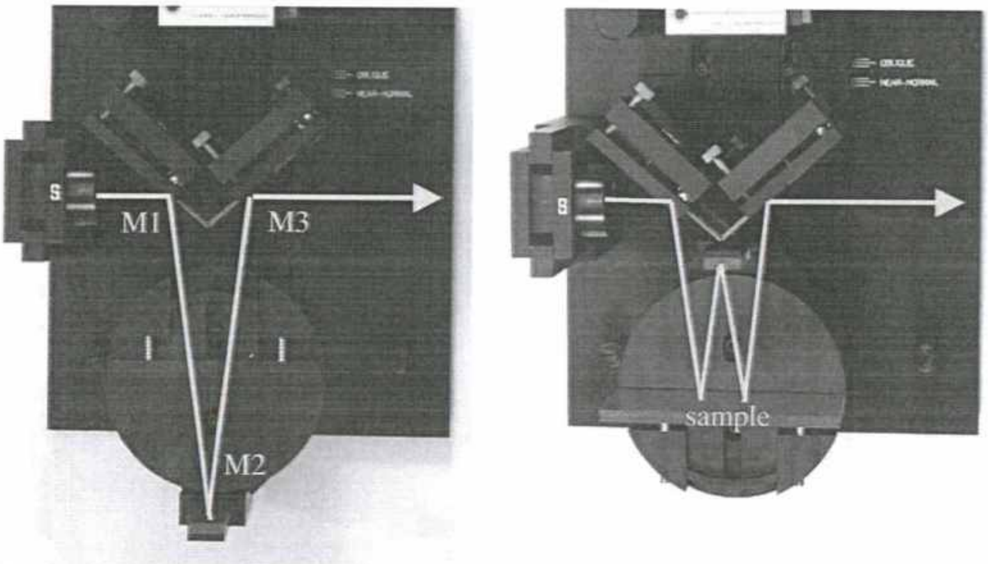


Figure 2.1 Top view of the VW set-up in the V-mode (left) and W-mode (right)

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:

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

where $j = 0.5\,(i + 1)$ for $i = 1, 3, 5$ and $j = 0.5\,i$ 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:

$$R = \sqrt{f} \cdot <R> + \Delta_{NL} + \Delta_{WL} + \Delta_{A} + \Delta_{P} + \Delta_{NU} \quad , \qquad (2)$$

in which

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

<R> is the average of the measured reflectance values,

Δ_{NL} is a contribution that accounts for detector non-linearity

Δ_{WL} is a contribution that accounts for a systematic deviation in the wavelength

Δ_{A} is a contribution that accounts for a systematic deviation in the angle of incidence

Δ_{P} is a contribution that accounts for a systematic deviation in the polarisation

Δ_{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

$$u_M = \tfrac{1}{2} <R>^2 \, u_f \quad , \qquad (3)$$

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:

$$u_R = 1.11 \cdot \sqrt{\tfrac{1}{5} \sum_{i=1,3,5} \frac{(R_i - <R+>)^2}{6}} \qquad (4)$$

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 Δ_{NL} is then

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

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 ¼ 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.

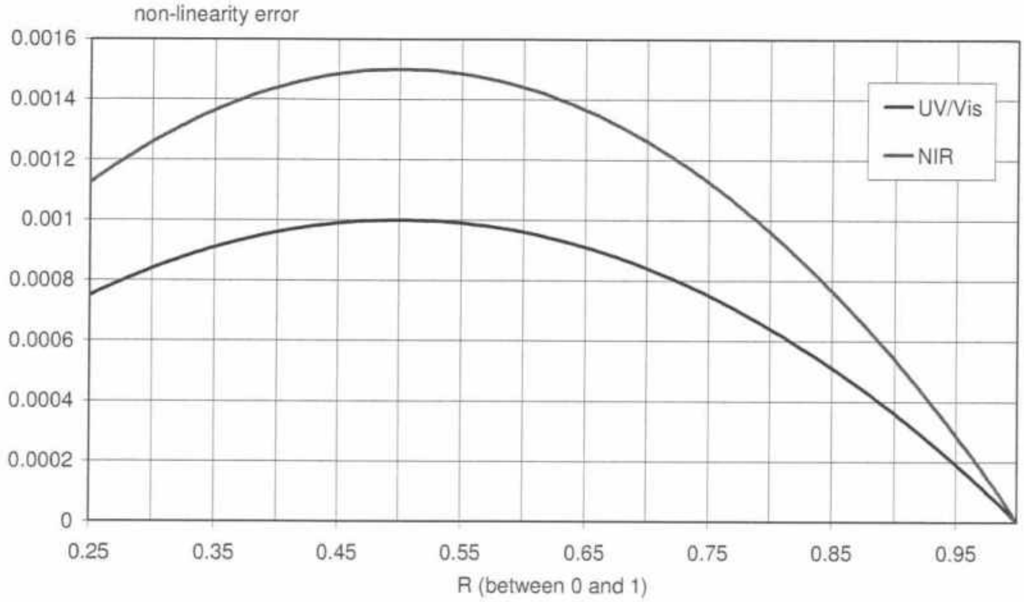


Figure 3.1 Worst-case detector nonlinearity (2 x standard uncertainty)

3.5 Wavelength uncertainty

The correction for a systematic deviation in the wavelength Δ_{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:

$$u_{WL} = \tfrac{1}{2}\left|\frac{\partial R}{\partial \lambda}\right| u_{\lambda} \approx \tfrac{1}{2}\left|\frac{\Delta R}{\Delta \lambda}\right| u_{\lambda} \quad . \tag{7}$$

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

- In the UV/Vis range → u_{λ} = 0.1 nm
- In the NIR range → u_{λ} = 0.15 nm

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

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

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.

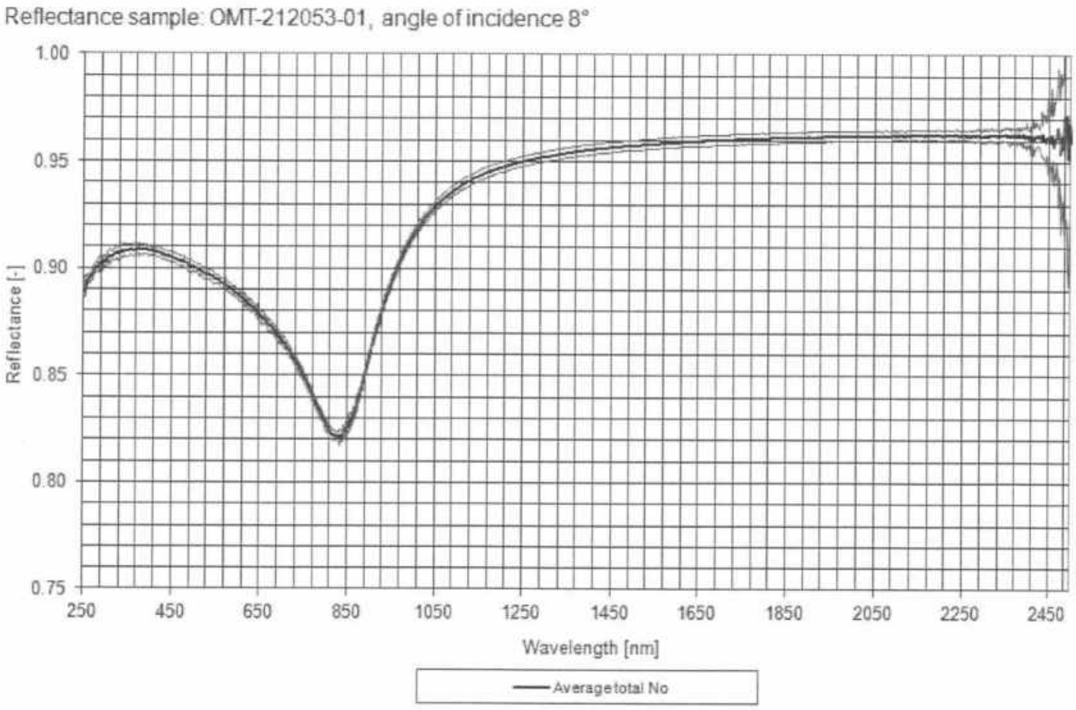


Figure 4.1 Near-normal (8°) Reflectance of the mirror OMT-212053-01

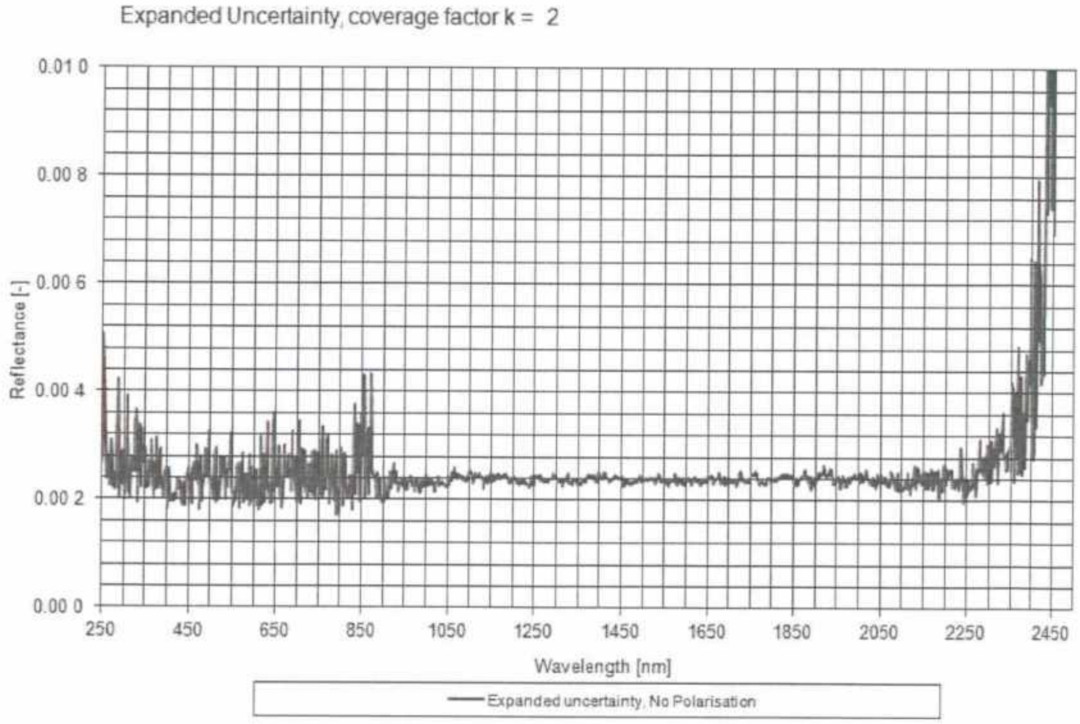


Figure 4.2 Standard uncertainty for mirror OMT-212053-01

5 Authorization

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

BETALINK INSTRUMENTATION & CALIBRATION SERVICES L.L.C.
Branch : Dubai
Al Quoz Industrial 4, P.O.Box :114810
Tel. : +971 4 3232 751, Fax : +971 4 3232 749
E-mail : dxblab@blcontrol.com
Website : www.blcontrol.com

BETALINK

بيتا لينك لأجهزة القياس والتحكم - ذ.م.م
فرع : دبي
القوز الصناعية ، ص.ب : ١١٤٨١٠
تلفون : ٩٧١ ٤ ٣٢٣٢ ٧٥١+ ، فاكس : ٩٧١ ٤ ٣٢٣٢ ٧٤٩+
بريد الكتروني: dxblab@blcontrol.com
موقع الانترنت: www.blcontrol.com

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

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

Calibration Date: 08-02-2015 **Calibration Due:** 07-02-2016

Environmental Conditions
Temperature: (23 ± 2) °C **Humidity:** (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).**

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

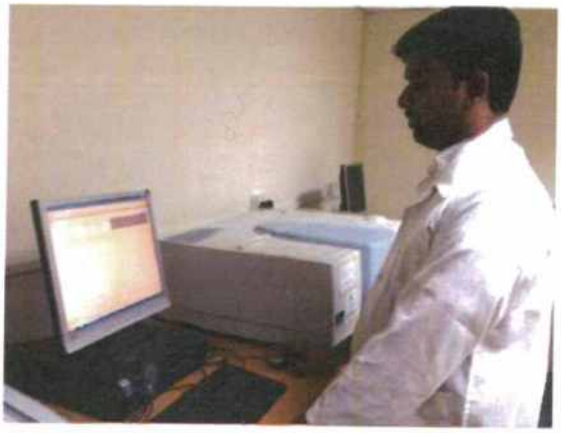
بيتا لينك لأجهزة القياس والتحكم - ذ.م.م
BETALINK DUBAI - U.A.E.
BETALINK INSTRUMENTATION & CALIBRATION SERVICES - L.L.C.

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).**

ماتيريال لاب
Material Lab

7: PICTURES



ص.ب ١١٤٧١٧، دبي، دولة الامارات العربية المتحدة
ماتيريال لاب
Material Lab
P.O.BOX: 114717, Dubai, United Arab Emirates

ماتيريال لاب- دبي، صندوق بريد : ١١٤٧١٧ هاتف : ٣٤٠٥٦٧٨ ٤ ٩٧١+، فاكس :٣٤٠٥٦٧٧ ٤ ٩٧١+
ماتيريال لاب جلف لفحص التربة - أبوظبي : صندوق بريد :٦١٨٣١، هاتف : ٥٥٠٣٠٤٠ ٢ ٩٧١+، فاكس : ٥٥٠٣٠٤١ ٢ ٩٧١+
Material Lab - Dubai, P.O. Box: 114717, Tel. + 971 4 3405678, Fax : + 971 4 3405677
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