School of Engineering
The University of Warwick
Coventry CV4 7AL United Kingdom
Tel: 07952 015771
Fax: 024 76418922
Email: r.thorpe@warwick.ac.uk

THERMAL CONDUCTIVITY MEASUREMENTS OF FLOOR SCREED SAMPLES FOR FRANCIS FLOWER GYPSOL LTD.

Carried out in the School of Engineering at the University of Warwick in April and June 2014 by Dr Roger Thorpe.

SUMMARY.

Samples supplied by the customer were tested using an Anter Quickline 10 Thermal Resistance Tester and found to have the following thermal conductivities:

Sample reference	Thermal conductivity (W/mK)
TS001	2.49
TS002	2.47
TS003	2.20

Mean sample temperature 30-31°C

METHOD

The Quickline machine is a steady state device. Its principle of operation is to pass a heat flux through a stack containing the sample and a reference material according to the ASTME E1530 guarded heat flow meter technique. The expected accuracy using this method for this resistance range is ± 4%.

The machine was calibrated for these measurements with standard samples of:

Sample 1: Stainless steel 304L 12.7mm

Sample 2: None (Since the Anter software will cannot accept a zero resistance this sample is defined as 'Stainless Steel 0.01mm thick')

Sample 3: Vespel 3.175mm

Sample 4 Vespel 6.35mm

In the calibration and in the measurements soft pads (Bergquist 3W/mK , 1.02mm) were used above and below the sample to protect the faces of the machine and provide good thermal contact.

DATA OUTPUT FROM CALIBRATION AND MEASUREMENTS

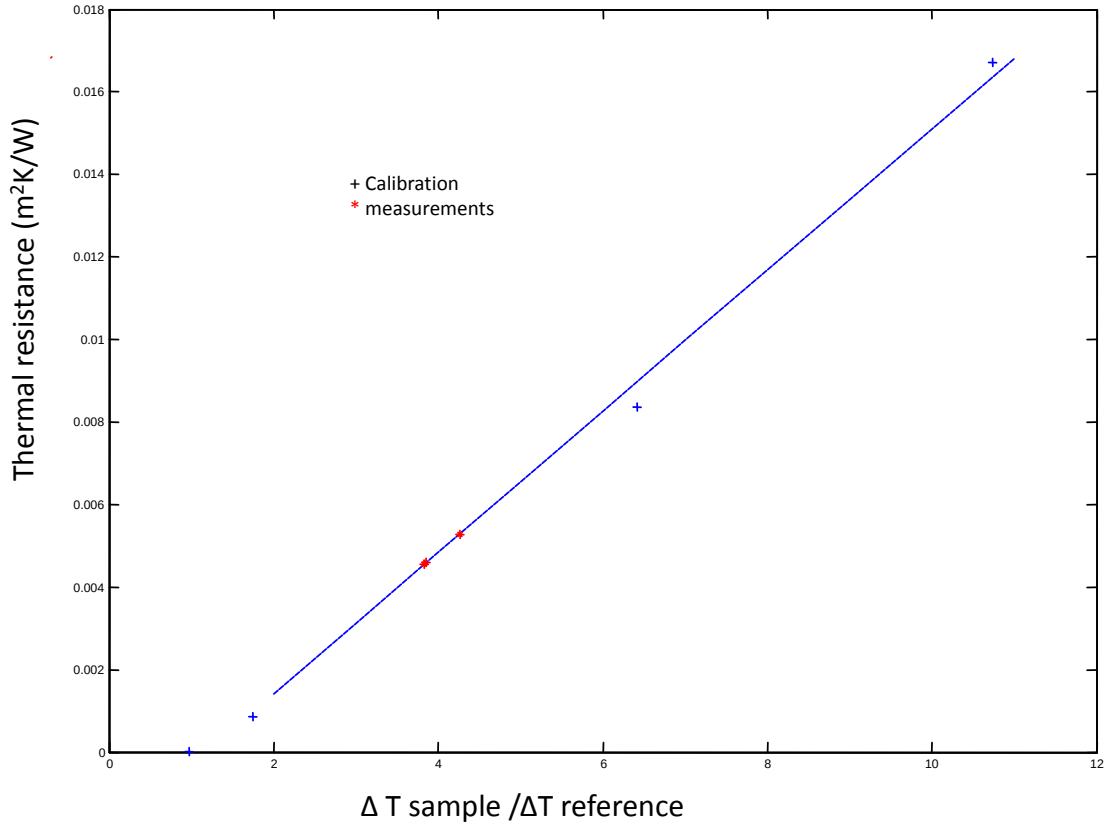


Figure 1 Calibration line. ΔTsample and ΔTreference are measured directly and then interpolated from this line to give the sample thermal resistance.

MODEL QuickLine-10 DATA ANALYSIS SOFTWARE
Program QL10 - Version 5.0
Anter Corporation 2003 (C)

QuickLine-10 Conductivity Test

Run Id: 1
File Name: TS001
Test Number: 1
Operator: rnt
Date: Tue Jun 24 15:27:27 2014

Calibration
Run Id: 1
File: ROGCAL2014b

Segment	Setpoint (C)	Stack delta	HFM Calibration Factor	Interfacial Resistance m²K/W	Rmin m²K/W	Rmax
1	12.06	29.34	1.7126e-003	2.0220e-003	6.8310e-007	1.6701e-002

Sensor	DVM Reading	Temperature (C)
Reference	1.2490	
Upper	1.4260	41.34
Lower	1.7440	18.95
Heat Sink	1.8270	13.10

delta T sample/delta T reference: 3.83
delta T sample: 22.39 (C)
delta T reference: 5.85 (C)
delta T stack: 28.24 (C)

Thickness: 0.4449 (inches)
1.1300 (cm)

Mean Sample Temperature: 30.14 (C)

Sample Thermal Resistance: 4.54e-003 (m²K/W)

Sample Thermal Conductivity: 2.49 (W/mK)

MODEL QuickLine-10 DATA ANALYSIS SOFTWARE
Program QL10 - Version 5.0
Anter Corporation 2003 (C)

QuickLine-10 Conductivity Test

Run Id: 1
File Name: TS002
Test Number: 1
Operator: rnt
Date: Wed Apr 23 19:03:19 2014

Calibration
Run Id: 1
File: ROGCAL2014b

Segment	Setpoint (C)	Stack delta	HFM Calibration Factor	Interfacial Resistance	Rmin m^2K/W	Rmax m^2K/W
1	12.06	29.34	1.7126e-003	2.0220e-003	6.8310e-007	1.6701e-002

Sensor	DVM Reading	Temperature (C)
Reference	1.2490	
Upper	1.4110	42.40
Lower	1.7540	18.24
Heat Sink	1.8430	11.97

delta T sample/delta T reference: 3.85
delta T sample: 24.15 (C)
delta T reference: 6.27 (C)
delta T stack: 30.42 (C)

Thickness: 0.4449 (inches)
1.1300 (cm)

Mean Sample Temperature: 30.32 (C)

Sample Thermal Resistance: 4.58e-003 (m^2K/W)

Sample Thermal Conductivity: 2.47 (W/mK)

MODEL QuickLine-10 DATA ANALYSIS SOFTWARE
Program QL10 - Version 5.0
Anter Corporation 2003 (C)

QuickLine-10 Conductivity Test

Run Id: 1
File Name: TS003
Test Number: 1
Operator: rnt
Date: Wed Apr 23 19:25:13 2014

Calibration
Run Id: 1
File: ROGCAL2014b

Segment	Setpoint (C)	Stack delta	HFM Calibration Factor	Interfacial Resistance	Rmin m²K/W	Rmax m²K/W
1	12.06	29.34	1.7126e-003	2.0220e-003	6.8310e-007	1.6701e-002

Sensor	DVM Reading	Temperature (C)
Reference	1.2490	
Upper	1.4040	42.89
Lower	1.7580	17.96
Heat Sink	1.8410	12.11

delta T sample/delta T reference: 4.27
delta T sample: 24.93 (C)
delta T reference: 5.85 (C)
delta T stack: 30.77 (C)

Thickness: 0.4567 (inches)
1.1600 (cm)

Mean Sample Temperature: 30.42 (C)

Sample Thermal Resistance: 5.28e-003 (m²K/W)

Sample Thermal Conductivity: 2.20 (W/mK)

MODEL QuickLine-10 DATA ANALYSIS SOFTWARE
Program QL10 - Version 5.0
Anter Corporation 2003 (C)

QuickLine-10 Calibration

Run Id: 1
File Name: ROGCAL2014b
Test Number: 1
Operator: RNT
Date: Tue Jun 24 15:25:31 2014

Calibration Summary

Setpoint #	Setpoint (C)	Stack delta	Slope	y-Intercept m²K/W	Rmin m²K/W	Rmax
1	12.06	29.34	1.7126e-003	-2.0220e-003	6.8310e-007	1.6701e-002

Sample: 1 Stainless Steel 304L
Sample: 2 Stainless Steel 304L
Sample: 3 Vespel
Sample: 4 Vespel□

Sample: 1 Stainless Steel 304L

Thickness: 0.5000 (inches)
1.2700 (cm)

Sensor	DVM Reading	Temperature (C)
Reference	1.2480	
Upper	1.4780	37.59
Lower	1.7050	21.60
Heat Sink	1.8350	12.43

Mean Sample Temperature: 29.60 (C)
Sample Thermal Conductivity: 14.64 (W/mK)
Sample Thermal Resistance: 8.67e-004 (m²K/W)

delta T sample/delta T reference: 1.75
delta T sample: 16.00 (C)
delta T reference: 9.16 (C)
delta T stack: 25.16 (C)

Sample: 2 Stainless Steel 304L

Thickness: 0.0004 (inches)
0.0010 (cm)

Sensor	DVM Reading	Temperature (C)
Reference	1.2480	
Upper	1.5180	34.78
Lower	1.6710	23.99
Heat Sink	1.8290	12.86

Mean Sample Temperature: 29.38 (C)
Sample Thermal Conductivity: 14.64 (W/mK)
Sample Thermal Resistance: 6.83e-007 (m²K/W)

delta T sample/delta T reference: 0.97
delta T sample: 10.78 (C)
delta T reference: 11.14 (C)
delta T stack: 21.92 (C)□

Sample: 3 Vespel

Thickness: 0.1250 (inches)
0.3175 (cm)

Sensor	DVM Reading	Temperature (C)
Reference	1.2490	
Upper	1.3670	45.49
Lower	1.7840	16.13
Heat Sink	1.8490	11.55

Mean Sample Temperature: 30.81 (C)
Sample Thermal Conductivity: 0.38 (W/mK)
Sample Thermal Resistance: 8.35e-003 (m^2K/W)

delta T sample/delta T reference: 6.42
delta T sample: 29.37 (C)
delta T reference: 4.58 (C)
delta T stack: 33.94 (C)

Sample: 4 Vespel

Thickness: 0.2500 (inches)
0.6350 (cm)

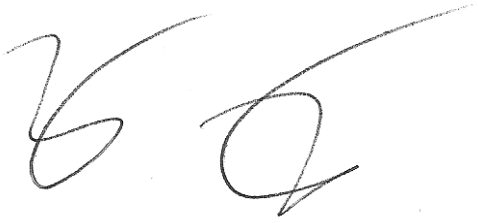
Sensor	DVM Reading	Temperature (C)
Reference	1.2490	
Upper	1.3350	47.75
Lower	1.8070	14.51
Heat Sink	1.8510	11.41

Mean Sample Temperature: 31.13 (C)
Sample Thermal Conductivity: 0.38 (W/mK)
Sample Thermal Resistance: 1.67e-002 (m^2K/W)

delta T sample/delta T reference: 10.73
delta T sample: 33.24 (C)
delta T reference: 3.10 (C)
delta T stack: 36.34 (C)□

DECLARATION

I declare that the experiments carried out and described here have been made with due care and objectivity.



Dr R. N.Thorpe B.Eng Ph.D.

25/06/2014