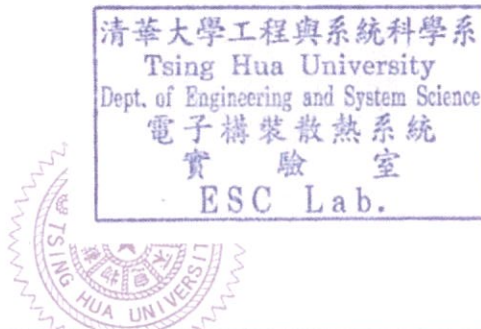


國立台灣清華大學 工程與系統科學系
先進冷卻散熱實驗室
(Advance Cooling Laboratory---ACL)

**Thermal Diffusivity
Performance Test Report**

Project Name:

P/N:



Notice: This document has released under a Non-Disclosure Agreement to:

CUSTOMER : Xbright Technology

Model: XT-701

This Document has been released from:

Approved By: Professor Lin, Wei-Keng

Wei-Keng Lin

Tester: Darren

Test Date: 2020.03.25

	National Tsing-Hua University--Taiwan ESS Dept.	Spreading Material Performance Test	Advance Cooling Laboratory---ACL	
Issued Date: <u>2020.03.25</u> Revised Date:		Document Ref. No: Inno-report-	Revision: 1.0	Pages: 1 / 8

1. Overview	2
1.1 Document History	2
1.2 Test Configuration	3
2. Thermal diffusivity Test Instrument for spreading material.....	4
2.1 Test Theory.....	4
(I) Angstrom Method Theory for measuring thermal diffusivity.....	4
(II) Test method for measuring the specific heat and thermal spreading conductivity.....	5
(III) Test Facility.....	6
(IV) System Characteristics.....	7
(V) Calibration test results.....	7
2.2 Test Results.....	8
2.2.1 Table 2-1— α , C_p , K_{sp} values for all samples.....	8



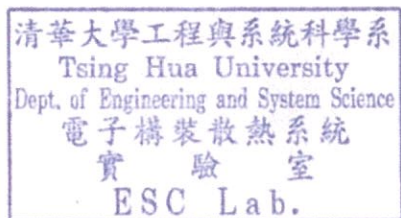
清華大學工程與系統科學系
Tsing Hua University
Dept. of Engineering and System Science
電子構裝散熱系統
實驗室
ESC Lab.

	National Tsing-Hua University--Taiwan ESS Dept.	Spreading Material Performance Test	Advance Cooling Laboratory---ACL		
Issued Date: <u>22020.03.25</u> Revised Date:		Document Ref. No: Inno-report-	Revision: 1.0	Pages: 2/ 8	

1. Overview

1.1 Document History

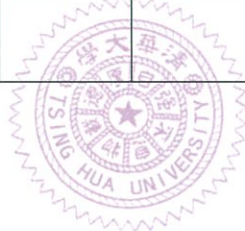
Item	Revision	Description	Date	Originator
1	1.0	<u>XT-701</u>	<u>2020.03.25</u>	Darren



	National Tsing-Hua University--Taiwan ESS Dept.	Spreading Material Performance Test	Advance Cooling Laboratory---ACL	
Issued Date: <u>2020.03.25</u> Revised Date:		Document Ref. No: Inno-report-	Revision: 1.0	Pages: 3 / 8

1.2 Test Configuration

Configuration				
Item	Model	Supplier	Description	Remark
1	<u>XT-701</u>		250*60.3*0.41mm	



清華大學工程與系統科學系
 Tsing Hua University
 Dept. of Engineering and System Science
 電子構裝散熱系統
 實驗室
 ESC Lab.

	National Tsing-Hua University--Taiwan ESS Dept.	Spreading Material Performance Test	Advance Cooling Laboratory---ACL	
Issued Date: <u>2020.03.25</u> Revised Date:		Document Ref. No: Inno-report-	Revision: 1.0	Pages: 4 / 8

2. Thermal diffusivity Test Instrument for spreading material

2.1 Test Theory

(I) Angstrom Method Theory for measuring thermal diffusivity

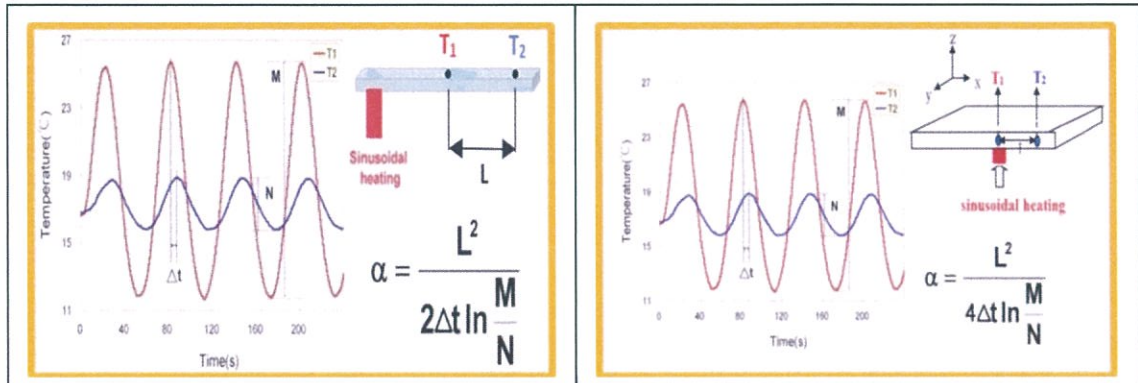


Fig. 1 One dimension Angstrom method

Fig. 2 Two dimension Angstrom method

L : Distance between two surface temperature measuring points (m)

$\Delta t = t_2 - t_1$: time delay (s)

M : Sinusoidal amplitude of the T_1 (°C)

N : Sinusoidal amplitude of the T_2 (°C)

k : Thermal conductivity of the test sample (W/m.K)

ρ : Density of the test sample (Kg/m³)

C_p : Specific heat of the test sample (KJ/Kg.K)

K_{sp} : Spreading thermal conductivity of the test sample (W/m.K)

	National Tsing-Hua University--Taiwan ESS Dept.	Spreading Material Performance Test		Advance Cooling Laboratory---ACL	
Issued Date: <u>2020.03.25</u> Revised Date:		Document Ref. No: Inno-report-		Revision: 1.0	Pages: 5 / 8

(II) Test method for measuring the specific heat

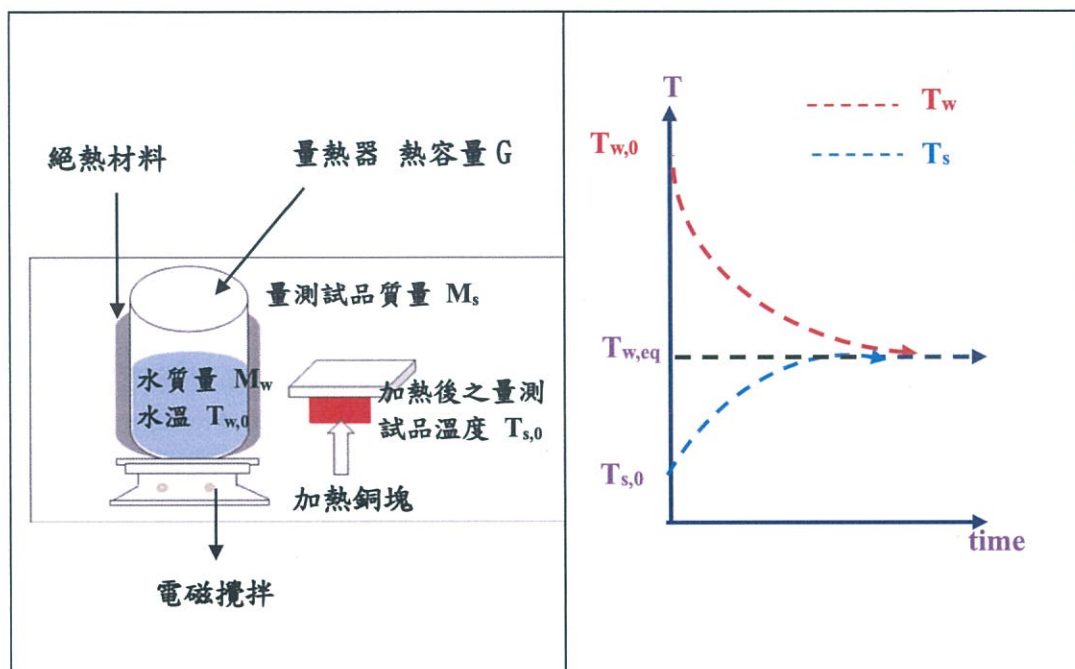


Fig. 3 Test fixture of the specific heat Fig. 4 Temperature trend for test of the Cp

金屬試樣放熱的熱量=水吸熱的熱量+量熱計吸熱的熱量

$$C_s = \frac{(M_w C_w + G)(T_{w,0} - T_{w,eq})}{M_s (T_{w,eq} - T_s)} ; \quad \alpha = \frac{K_{sp}}{\rho C}$$

item	description	item	description
C	Sample specific heat (J/g,K)	α	thermal diffusivity (m ² /s)
M _w	添加水之質量(g)	G	絕熱後量熱計之熱容 (J/K)
C _w	水之比熱容(J/g·k)	T _{s,0}	待測物起始之溫度(°C)
T _{w,eq}	系統之熱平衡水溫度(°C)	T _{w,0}	水之初始溫度(°C)
M _s	待測樣品質之值量	K _{sp}	待測樣品之有效熱傳導係數

	National Tsing-Hua University--Taiwan ESS Dept.	Spreading Material Performance Test	Advance Cooling Laboratory---ACL	
Issued Date: <u>2020.03.25</u> Revised Date:		Document Ref. No: Inno-report-	Revision: 1.0	Pages: 6/ 8

(III) Test Facility

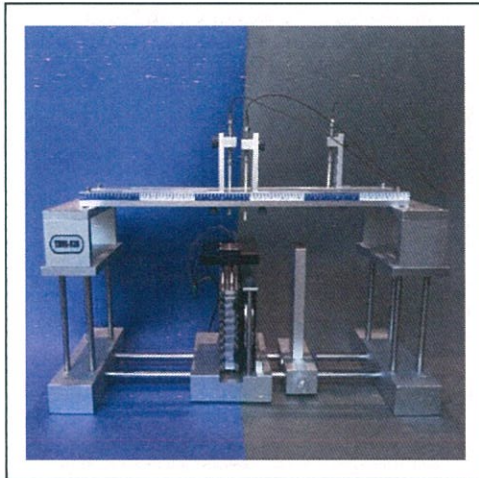


Fig.5 熱擴散率量測平台



Fig. 6 比熱容量測系統

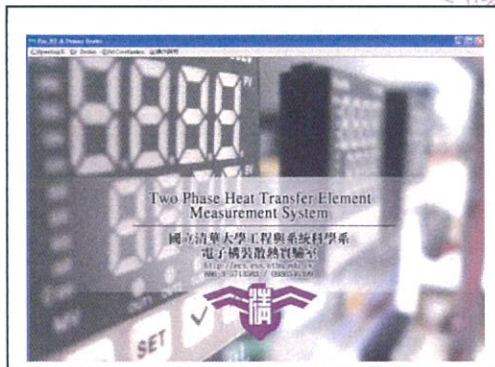


Fig. 7 熱擴散率量測程式封面

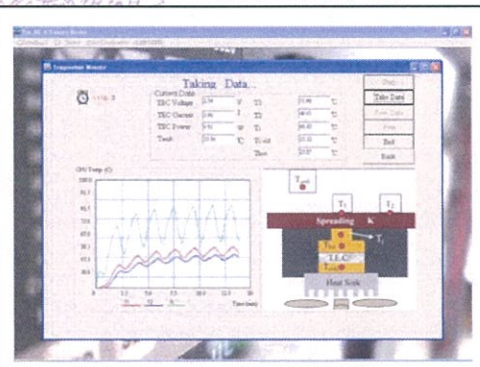


Fig. 8 熱擴散率溫度量測介面圖

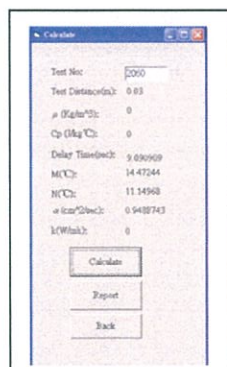


圖 9.自動化計算程式介面

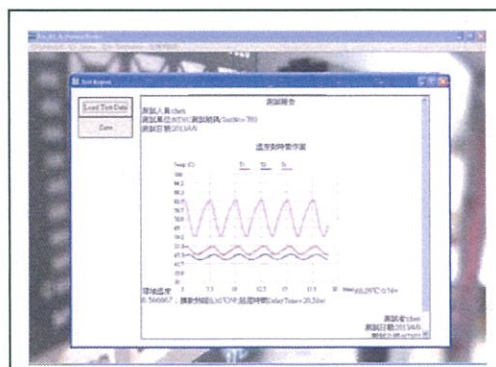


圖 10 測試報告輸出程式介面圖

	National Tsing-Hua University--Taiwan ESS Dept.	Spreading Material Performance Test	Advance Cooling Laboratory---ACL	
Issued Date: <u>2020.03.25</u> Revised Date:		Document Ref. No: Inno-report-	Revision: 1.0	Pages: 7/ 8

(IV) System Characteristics:

- IV-1. 可測試一維及二維之任何均溫片樣品
- IV-2. 利用個人電腦的快速處理能力，可在短時間內自動擷取大量測試數據，並利用統計原理求取客觀的數值，重現性極高
- IV-3. 全部測試過程採電腦化方式進行，除在電腦螢幕上及時顯示結果外，同時將數據存入硬碟機中，做永久儲存，方便日後之數據處理
- IV-4. 採用 Visual Basic 高階程式語言撰寫之軟體，操作簡單
- IV-5. 精密的感測器，可自動量測溫度、電壓、電流與加熱功率，準確度高，隨時提供特性圖表輸出、性能監視等輔助功能

(V) Calibration test results:

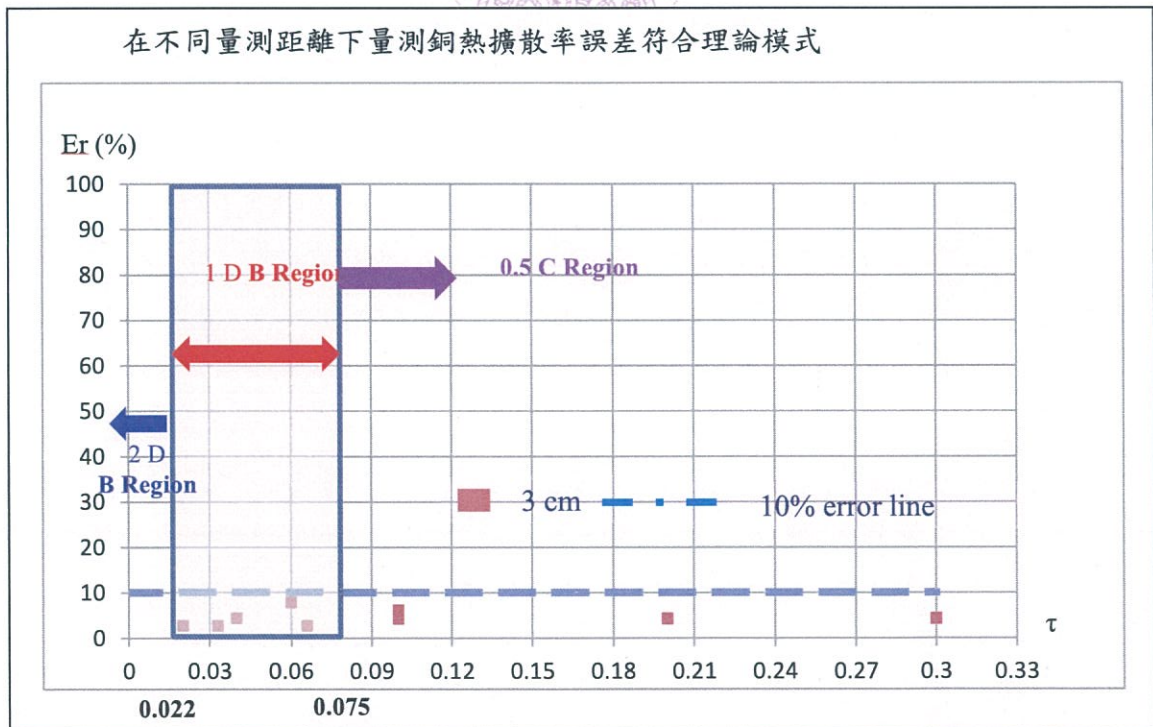


Fig.11 熱擴散率誤差結果符合之 Angstrom method 理論模式

	National Tsing-Hua University--Taiwan ESS Dept.	Spreading Material Performance Test	Advance Cooling Laboratory---ACL	
Issued Date: <u>2020.03.25</u> Revised Date:		Document Ref. No: Inno-report-	Revision: 1.0	Pages: 8 / 8

2.2 Test Results

2.2.1 Table 2-1— α , C , K_{sp} values for all samples

Table 2.2.1 TDMI 測量的樣品熱擴散率

Item	<u>XT-701</u>
$\rho(\text{g}/\text{cm}^3)$	$\rho_{ave,}=2.75$
$C(\text{J}/\text{g} \cdot ^\circ\text{C})$	0.883
$L \times W \times T (\text{mm}^3)$	250*60.3*0.41
$\tau=T/W$	$\tau=0.41/60.3=0.0068<0.022$
mode	2D mode (A)
$\alpha (\text{cm}^2/\text{s})$ (Homogeneous)	$\alpha_{total}=0.88$
$K_{VC,TDMI}(\text{W}/\text{m}\cdot\text{k})$	$K_{VC-A}=2.75*0.883*0.88*100=213.686$
ΔT (at $L=3\text{cm}$, $P=10\text{W}$)	15.7 $^\circ\text{C}$
ΔT (sine wave)	12.6 $^\circ\text{C}$

