

SINCE 1889



# Power Semiconductor Mounting Board Thermal Character Evaluation/ Analysis Equipment

## TE100



SINCE 1889



## Power Semiconductor Mounting Substrate Thermal Characteristics Evaluation Equipment

International Workshop for  
Advanced System Integration and Packaging (ASIP)  
Purdue University

December 6<sup>th</sup> 2023

**Yamato Scientific Co.,Ltd.**



## Background

With the accelerated development of next-generation power semiconductors (SiC and GaN), power electronics devices are **becoming smaller and more powerful**, and the market for power electronics devices is expected to expand, including electric vehicles.

However, power electronics devices are **exposed to high temperature** conditions, resulting in efficiency degradation and reliability issues. In order to solve these issues, manufacturers of components and power electronics equipment are aiming for **higher heat dissipation and higher reliability**.

Since Nov. 2016, we have been conducting joint research with Dr. Suganuma on “**Evaluation Methods for Thermal Characteristics** of Next Generation Power Electronics Substrates” Furthermore, a project to standardize the evaluation method to **ISO standards** is being conducted in parallel under the leadership of Dr. Suganuma.

2

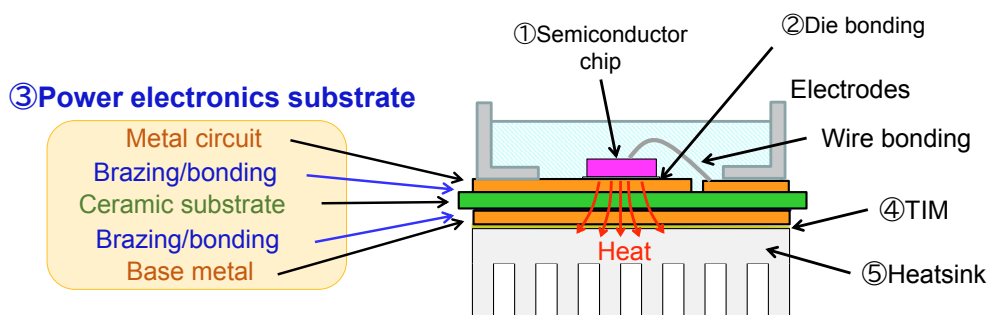


## Challenge: Thermal performance evaluation

### ● General Power Device Structure

Main path of generated heat (250° C)

①Semiconductor chip ⇒ ②Die Bonding ⇒ ③ **Power electronics substrate** ⇒ ④TIM ⇒ ⑤ Heatsink



Power Module Example

Optimization of high thermal conductivity and high heat dissipation design for each component is required  
⇒ **More accurate thermal characterization is needed.**

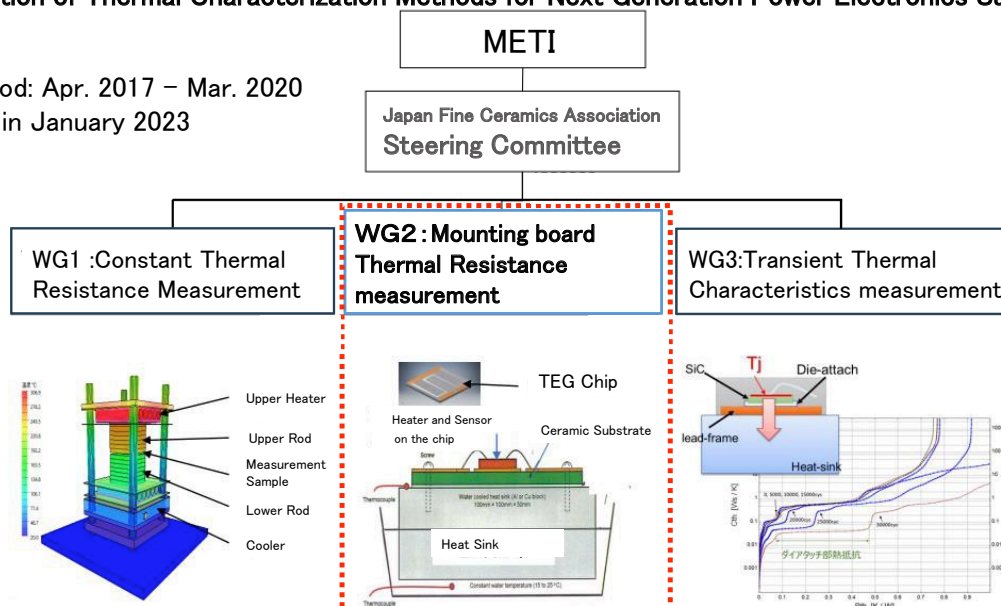
3



## International Standardization Project Structure

Standardization of Thermal Characterization Methods for Next Generation Power Electronics Substrates

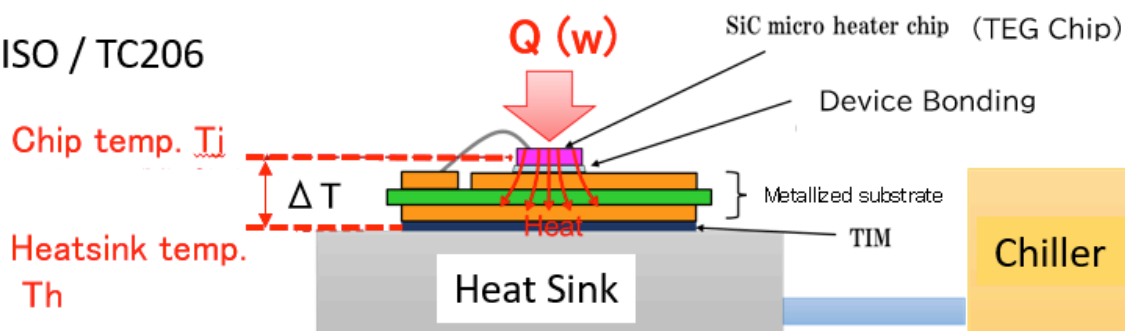
Project period: Apr. 2017 – Mar. 2020  
ISO Issuing in January 2023



## Development: Evaluation Method

### Evaluation Method (System)

ISO / TC206



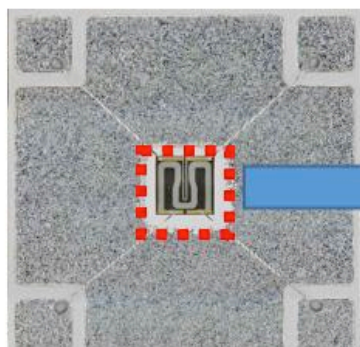
Define Effective thermal resistance as  $R_{th}$

$$R_{th} = (T_j - T_h) / Q$$

$$R_{th} = \Delta T / Q$$

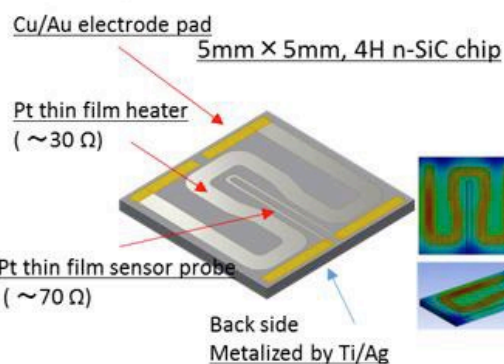


## Development: TEG Chip



Standard sample  
30mm × 30mm

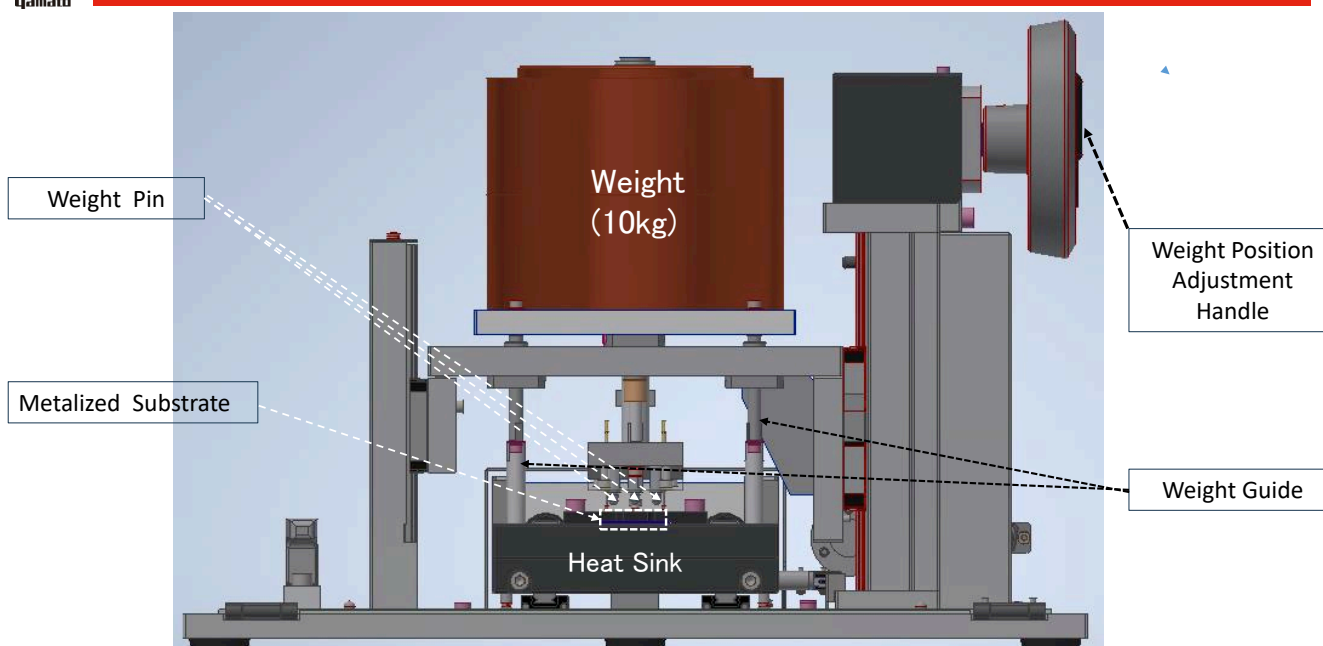
### TEG Chip( SiC micro heater chip)



6



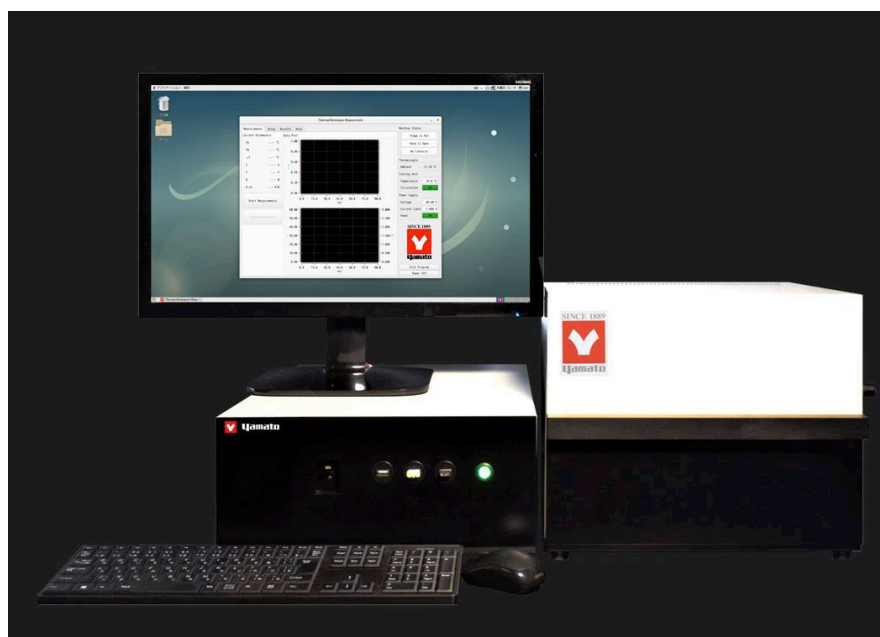
## Internal Mechanism



8



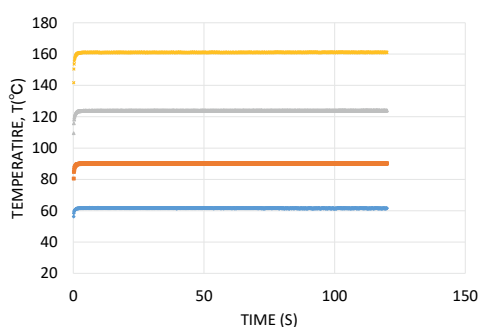
## Appearance of the Equipment



9



## Temperature stability of TEG chip



P:267W,  $\Delta T$ :131-132°C

P:196W,  $\Delta T$ :96°C

P:131W,  $\Delta T$ :62-63°C

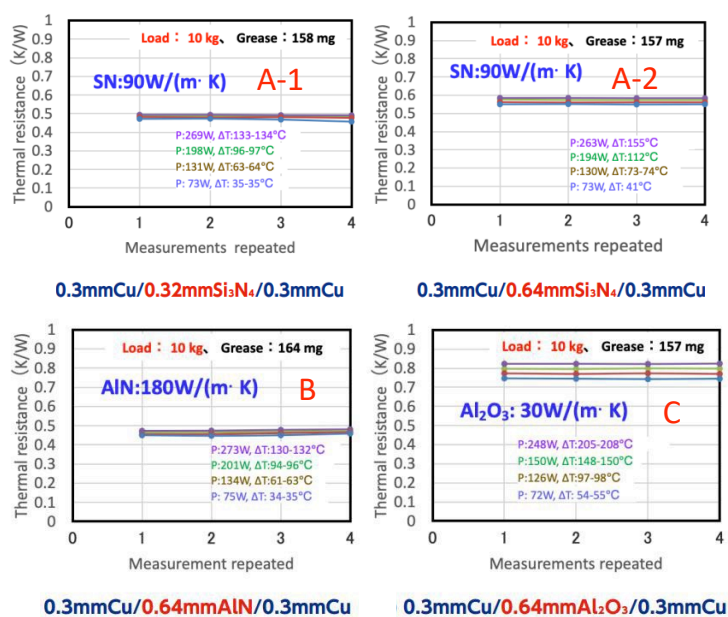
P: 73W,  $\Delta T$ : 34-35°C

Q (W)	Chip Temperature				
	Ave. (°C)	Variance	SD	Mac Temp..(°C)	Min. Temp.(°C)
266.9	161.0	0.0079	0.089	161.3 (+0.3)	160.8 (-0.2)
196.3	123.9	0.0046	0.068	124.1 (+0.2)	123.5 (-0.4)
130.5	90.2	0.0124	0.111	90.6 (+0.3)	90.0 (-0.2)
72.8	61.6	0.0097	0.098	61.8 (+0.2)	61.3 (-0.4)

Within about  $\pm 0.5^\circ\text{C}$  of average temperature



## Measurement Results



11



## Proposal to ISO

### ○ Progress

Jan. 2020: NP proposal to ISO

Sep. 2022: FDIS approval

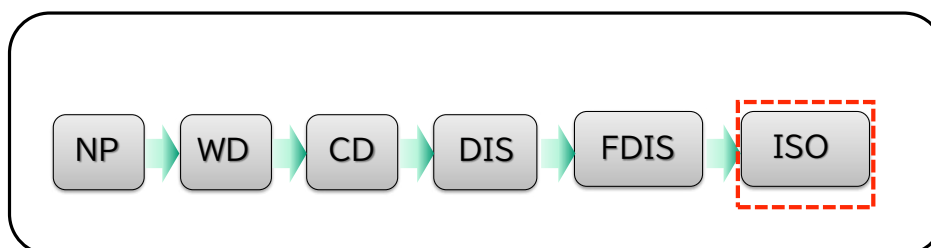
Jan. 2023: ISO Issuing

NP: New Proposal


DIS: Draft of International Standard

FDIS: Final DIS

### ISO Process



12



SINCE 1889

# ISO Issuing

Annual Meeting 2023

Applications OBP English

ISO Standards About us News Taking part Store

Search

← ICS ← 81 ← 81.060 ← 81.060.30

## ISO 4825-1:2023

Fine ceramics (advanced ceramics, advanced technical ceramics) --Test method for thermal property measurements of metalized ceramic substrates — Part 1: Evaluation of thermal resistance for use in power modules

**Abstract**

This document specifies a method for measuring the thermal resistance between a heater chip and a cold plate with the heater chip mounted on a metalized ceramic substrate, imitating a silicon carbide (SiC) high-output power module. This measurement represents an index of the heat dissipation characteristics of a metalized ceramic substrate used in a high-output power module.

[Preview](#)

**General information**

Status : Published	Publication date : 2023-01
Edition : 1	Number of pages : 12
Technical Committee : ISO/TC 206 Fine ceramics	
ICS : 81.060.30 Advanced ceramics	

**Buy this standard**


Format	Language
✓ PDF + ePub	English
Paper	English

CHF 61 [Buy](#)

※ : Quoted from the official ISO website

SUSTAINABLE DEVELOPMENT GOALS

13



SINCE 1889

# Conclusion

## Thermal characteristics evaluation and analysis equipment + SiC TEG chip

1. Effective thermal resistance of power electronics boards can be easily evaluated
2. TEG chip can simulate power module drive conditions.
3. TEG chip 's platinum probe enables accurate and stable temperature measurement.
4. Windows-like software is installed for easy operation.
5. Evaluation method is standardized in ISO4825-1:2023

14



### Caution

The specifications and performance figures of the products listed in this catalog are presented as a user guide under general operating conditions. When using the product, please understand the contents of the instruction manual and use the product correctly. Please note that we cannot be held responsible for any damage to persons or property caused by using the product outside the conditions of use described in the instruction manual.

- Specifications and appearance are subject to change for improvement without prior notice.
- The product colors may appear different from the actual colors due to the shooting and printing inks.
- Company names, product names, and logos are trademarks or registered trademarks of our company Corporation or of their respective owners.

SINCE 1889



For the Future of Science & Technology

## Yamato Scientific Co., Ltd.

**Yamato Scientific Co., Ltd.**

International Sales Department:

Harumi Island Triton Square Office Tower Y, 36F

1-8-11 Harumi, Chuo-ku, Tokyo 104-0053, Japan

TEL: +81-3-5548-7122 FAX: +81-3-5548-0132

<Customer Service/Technical Support> [english-website@yamato-net.co.jp](mailto:english-website@yamato-net.co.jp)

**Yamato Scientific Shanghai Corp.**

Cat.No: C1447A

Room 1001-1002, Block B, Xinyan Building,

No.65 Guiping Road, Xuhui District, Shanghai, China

TEL: +86-21-6443-5319 FAX: +86-21-5452-0268

<Customer Service/Technical Support> [info@yamato-shanghai.com](mailto:info@yamato-shanghai.com)

**Yamato Scientific America Inc.**

925 Walsh Ave. Santa Clara, CA 95050, U.S.A.

TEL: +1-408-235-7725 FAX: +1-408-235-7730

<Customer Service Customer> [Service@yamato-usa.com](mailto:Service@yamato-usa.com)

<Technical Support > [www.yamato-usa.com](http://www.yamato-usa.com)