

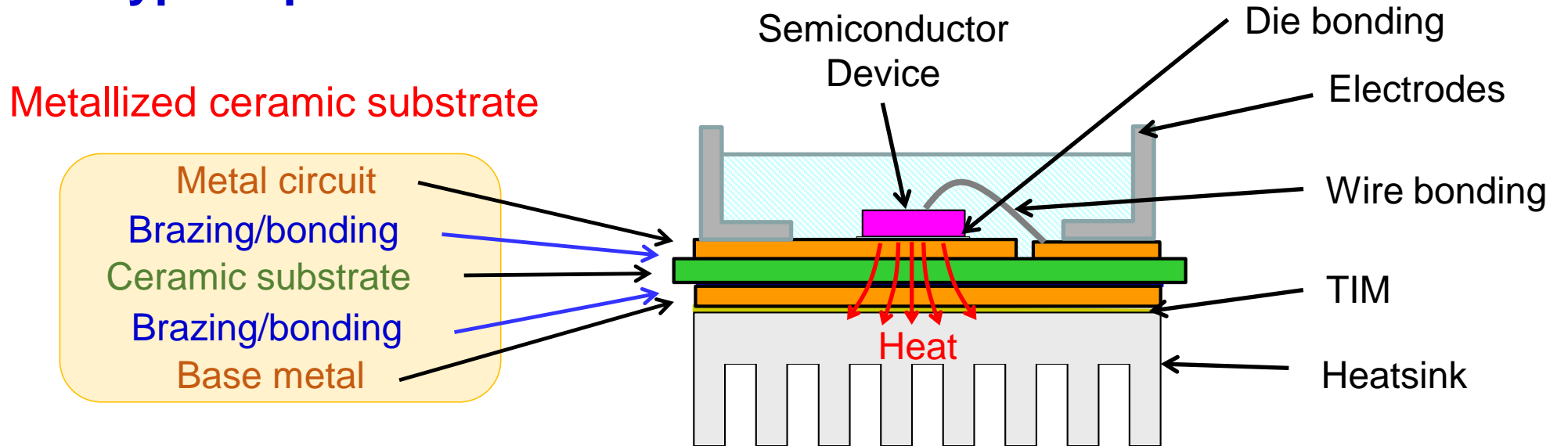
Thermal resistance measurement of metalized ceramic substrates for next generation power modules toward international sandardization

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3D Power Electronics Integration and Manufacturing

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Attend In-person or Virtually

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● Schematic of a typical power module:



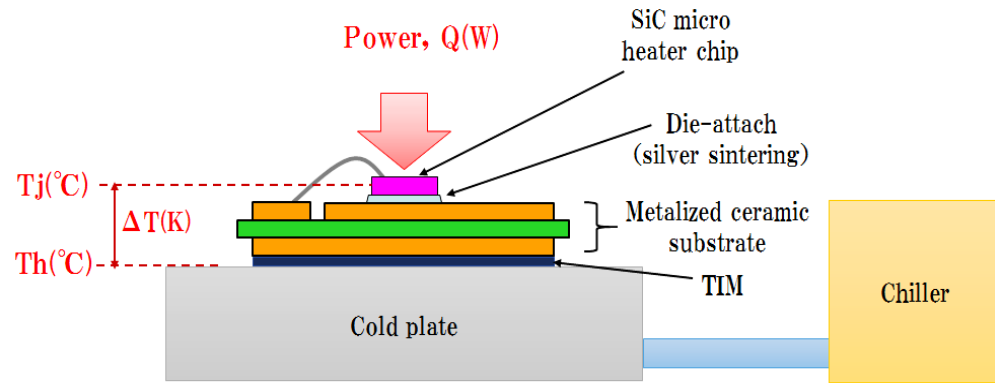
● The issue in power module design: “Thermal management”

- ✓ Output power and power density is increasing => **Higher heat generation**
- ✓ Heat transportation: Semiconductor dies => **Cooling system**
- ✓ Major heat path: via circuit board made of metallized ceramic substrate

=> **Precise thermal characterization standard is required.**

Experimental concept of evaluation for R_{th}

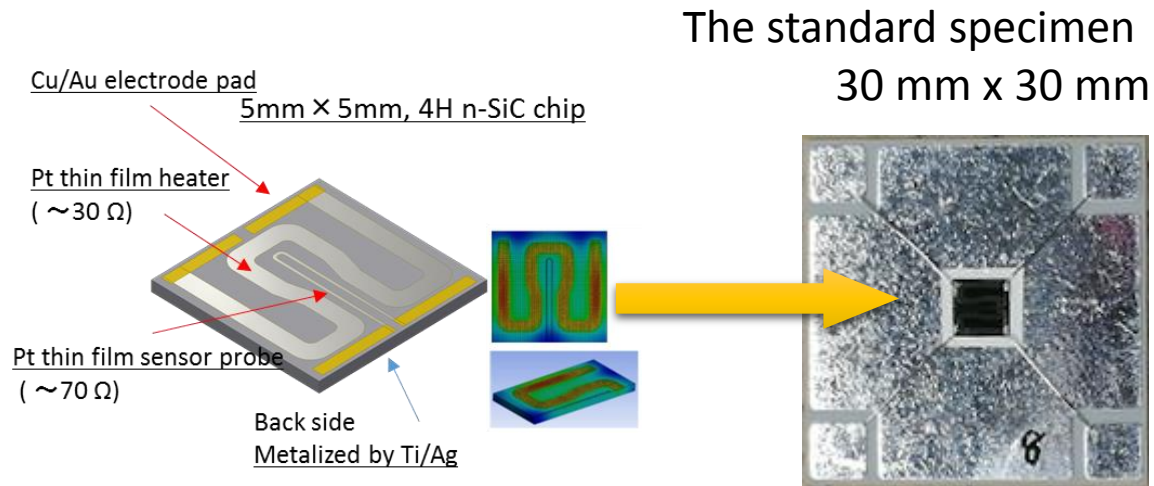
- The method is under discussion at ISO TC206.



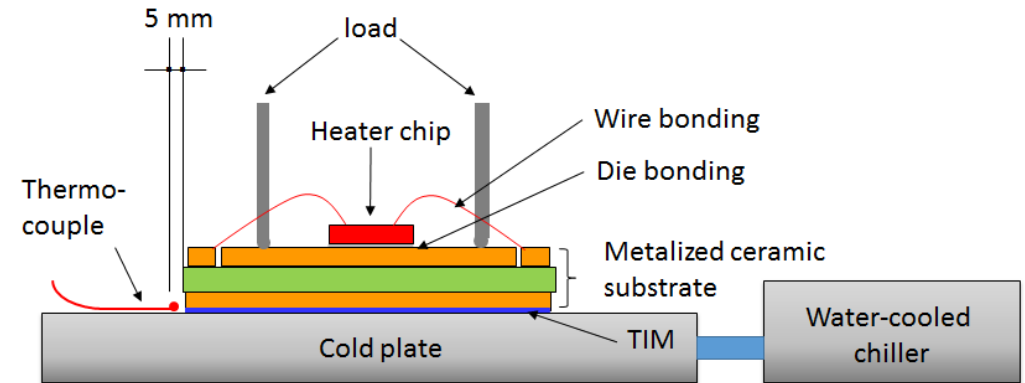
$$R_{th} = (T_j - T_h) / Q$$

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

- SiC micro heater chip improves the accuracy of R_{th}



- Experimental configuration



- This machine is under development in Yamato Scientific Co., Ltd.

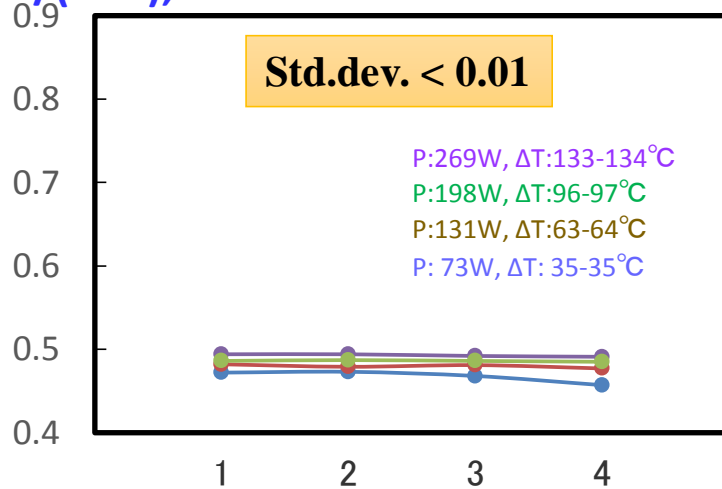


Stable, converged, and accurate R_{th}

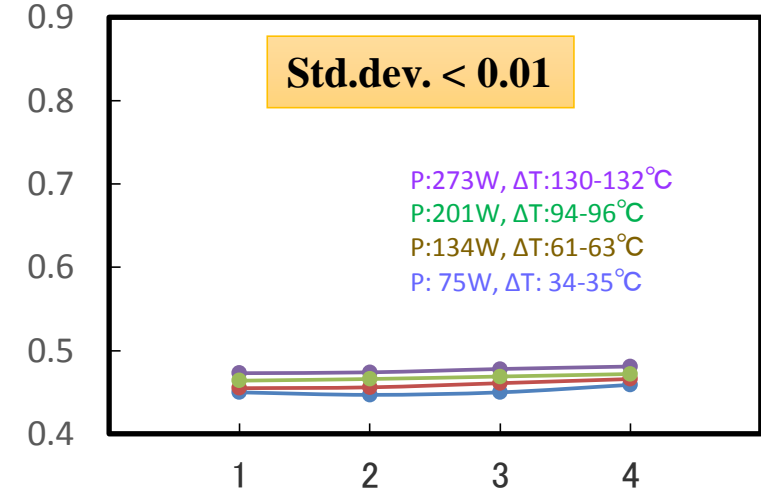
Thickness of Cu layer = 0.3 mm, Load: 10 kg, Thermal grease: ~160 mg

Thermal resistance (K/W)

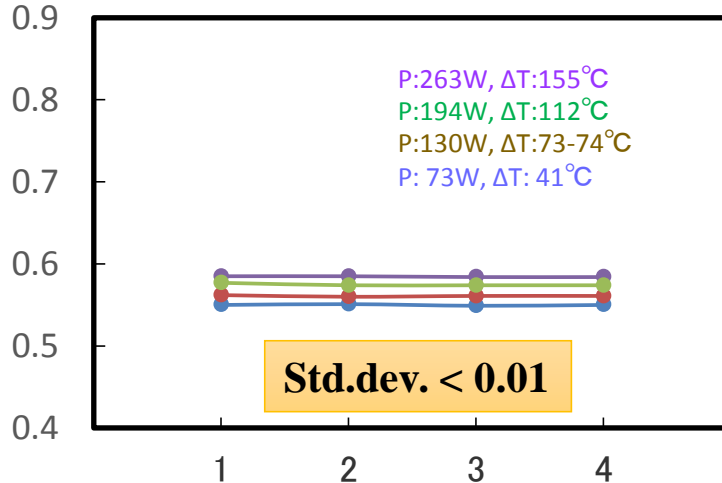
Si₃N₄: 90 W/(m·K), Thickness 0.32 mm



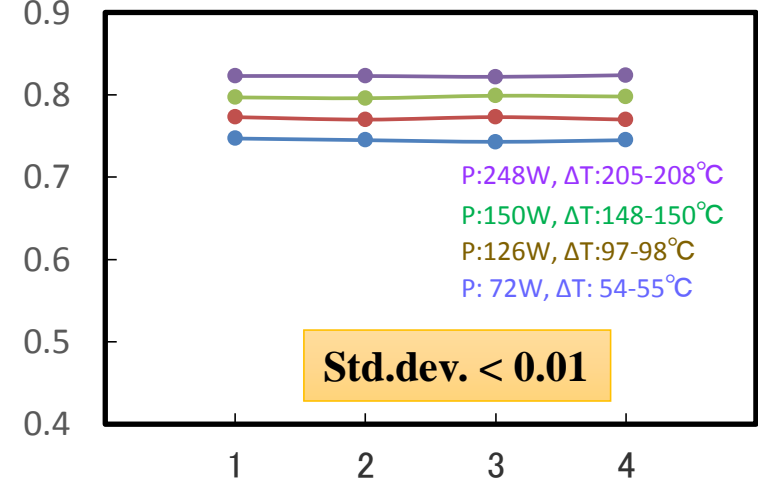
AlN: 180 W/(m·K), Thickness 0.64 mm



Si₃N₄: 90 W/(m·K), Thickness 0.64 mm



Al₂O₃: 30 W/(m·K), Thickness 0.64 mm



Individual measurements trials

1. The method proposed to ISO evaluates the thermal resistance R_{Th} in a typical usage of metalized ceramic substrate with die-attachment of a micro-heater chip that mimics a real power device chip.
2. The comprehensive measurement conditions defined in the standard method assures the reliability, reproducibility, and excellent resolution of obtained R_{Th} ; The standard deviations of individual four trials remains much less than 0.01 K/W.
3. The example measurements for several types of metalized ceramic substrates exhibited realistic and reasonable R_{Th} .
4. The standard measurement machine will be in the market 2021.

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“Thermal characterization of ceramic substrates for next generation power semiconductors”