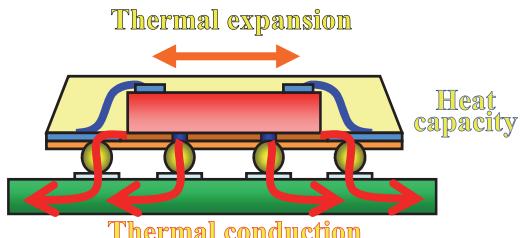


# For realization of more accurate thermal design

In thermal design, in order to reduce the deviation between the temperature distribution of the device during operation and the results of the heat transfer calculations, the exact model and accurate properties are required. The best way for realizing the optimal thermal design are to apply a suitable technique for measuring the thermophysical property values of used material, furthermore, to be evaluate the heat release characteristics of an actual device.

## Thermal properties of materials

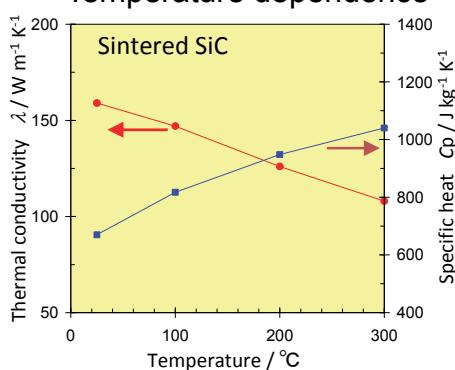


Thermal conductivity, heat capacity, and thermal expansion are important thermophysical properties for thermal design of device with heat generator (e.g. semiconductor package).

	Thick	Bulk	Plate, Film	Thin film
Thermal conductivity	Steady heat flow method			3ω method
Thermal diffusivity		Flash method	AC calorimetry	Thermo-reflectance method
Thermal expansion	Strain gauge		Laser interferometry	
Heat capacity (specific heat)		Thermo mechanical analysis		Bending method
			DSC method	

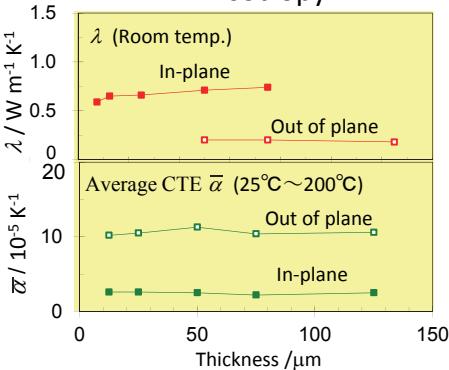
It's very important to select a best measuring method !

## Temperature dependence



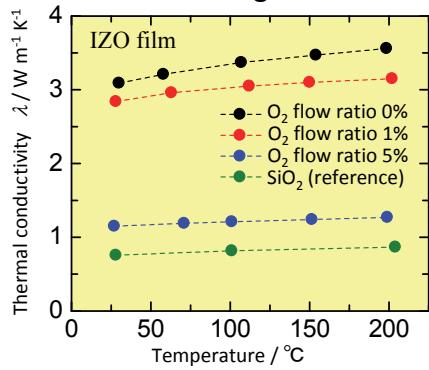
Thermal conductivity at 300 °C is approximately two-thirds of it at room temperature.

## Anisotropy



Anisotropy of thermal conductivity and thermal expansion may be caused by anisotropy of the molecule structure.

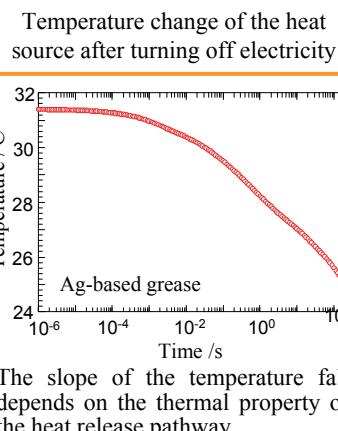
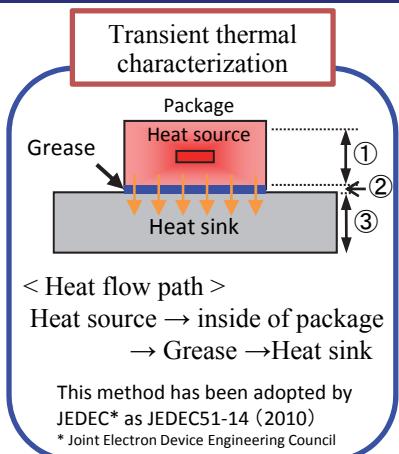
## Film forming condition



Thermal conductivity varies depending on the O<sub>2</sub> flow ratio at the sample preparation.

Sample provided by Prof. Y. Shigesato (Aoyama Gakuin Univ.)

## Transient thermal characterization of a device



Transient thermal characterization method visualizes the thermal properties of heat transfer path for a device, and enables the determination of the bottle-neck part of the heat release pathway in it. Furthermore, the dependence of the heat release characteristics on the types of material (e.g. thermal grease) can also be identified.

## Structure Function

(Thermal capacitance vs. thermal resistance)

