APPLICATION **NOTE**

Measuring the Thermal Diffusivity of Small Semiconductor Devices by Means of the *ZoomOptics* of the LFA 467 *HyperFlash*

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Introduction

Thanks to continuing development in the electronics industry, the size of electronic components has drastically reduced in recent years. A related issue has been improvements in efficiency: Reductions in component size translate to less space for heat dissipation – while the amount of heat being generated is on the rise. To compensate, electronic components must have a high thermal conductivity for fast heat control.

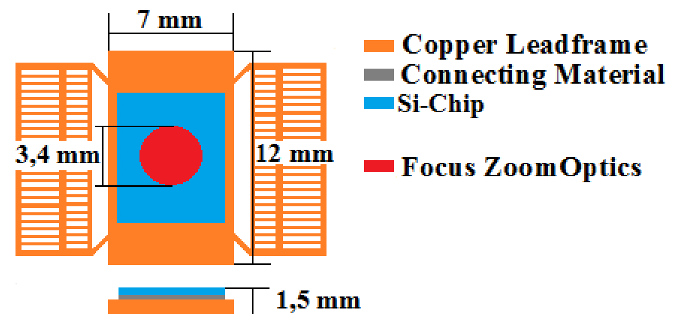
The LFA 467 *HyperFlash* allows for thermal conductivity measurements on the smallest of electronic components. Its fast data acquisition rate of 2 MHz makes measurement on very thin samples possible, while the patented *ZoomOptics* allows user to focus exclusively on the relevant sample areas.

Samples and Experimental

A total of five semiconductor devices were investigated:

- 1 copper lead frame without structure
- 2 structurally identical semiconductor devices with structure A
- 2 structurally identical semiconductor devices with structure B

The semiconductor devices consist of a copper leadframe onto which an Si chip was applied by means of connecting material (e.g., adhesive or solder). Semiconductor devices A and B differ only with regard to the connecting material. Figure 1 shows the schematic of such a sample.



1 Schematic of a semiconductor device

The measurements were carried out with the LFA 467 *HyperFlash* at room temperature. The entire sample was illuminated; the detector, however, was focused on a diameter of only 3.4 mm by means of the *ZoomOptics*, see figure 1.

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Results and Discussion

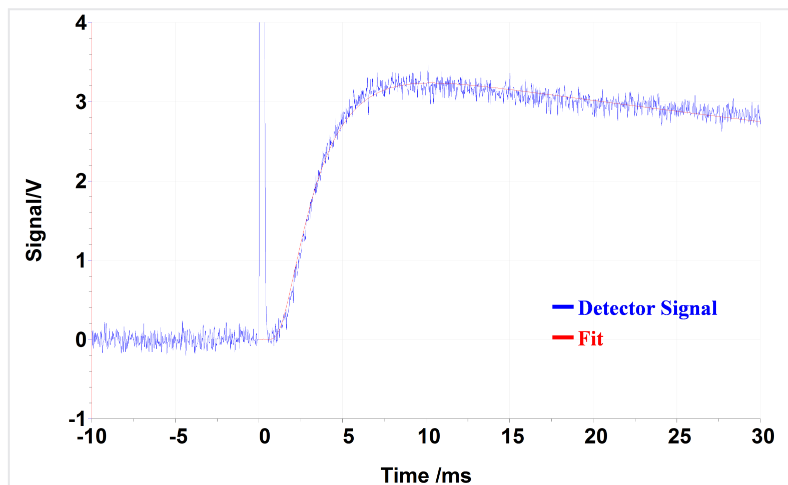
The basic requirement for meaningful results is good agreement between the detector signal and the mathematical fit. Despite the radiation peak at the beginning of the signal (caused by the fact that the sample geometry is not ideal), this applies to all measurements, as shown in figure 2.

The results of all samples at room temperature are depicted in figure 3.

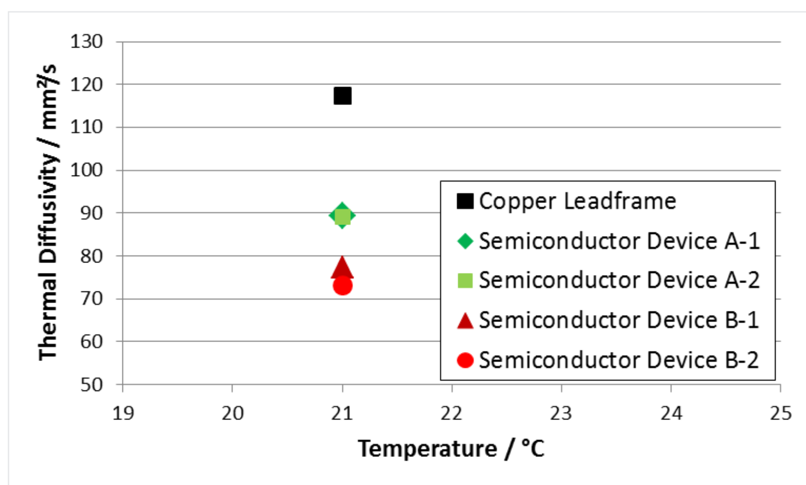
The measured value of the copper lead frame without structure was identical to the literature value for copper (117 mm²/s [1]).

The thermal diffusivity of the structurally identical semiconductor devices A-1 and A-2 barely differ from one another, which attests to the good reproducibility of the measurement (green).

Semiconductor devices B-1 and B-2 yield a considerably lower thermal diffusivity (red) due to a different connecting material. However, when comparing the two components B-1 and B-2, one will again find reproducibility in the measurement results. The difference of approx. 5% indicates a higher contact resistance for B-2 and thus a weaker thermal connection between the Si chip and the copper.



2 Detector signal and analytical fit of a semiconductor device



3 Thermal diffusivity of a semiconductor device at room temperature

Summary

The LFA467 *HyperFlash* with *ZoomOptics* allows for the investigation of small samples or of only select areas within a sample. Peripheral areas or areas with differing sample thickness can thus be purposefully excluded, considerably increasing both the measurement's precision and the meaningfulness of its results.

References

[1] Y.S. Touloukian: Thermophysical Properties of Matter – Vol. 10: Thermal Diffusivity; New York (1973)

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