APPLICATION**NOTE**

LFA 467 *HT HyperFlash*®: Fastest Mini-Tube Furnace with Excellent Stabilization Behavior for Shortest Measurement Times and High Sample Throughput

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1 LFA 467 *HT HyperFlash*®

Introduction

The use of laser/light flash systems (LFA) for the determination of thermal diffusivity is well-established – specifically in the fields of thermophysical properties testing. The development of new materials or electronic components is also accompanied by the enhancement of conventional LFA systems. The LFA 467 *HT HyperFlash*® was designed to address the demands arising from trends in both science and industrial applications. A variety of new features – such as flash applications to beyond 1250°C, *ZoomOptics*, an ultrafast sampling rate (2 MHz), a short pulse width (< 20 µs), etc. – accommodate the requirements for state-of-the-art applications such as thin and highly conductive materials (thin films).

Furthermore, conventional LFA systems find their way into all kinds of laboratories ranging from R&D to quality assurance. Extensive use of this technique requires additional characteristics to address practicality issues. Besides high precision and a small footprint, a high sample throughput is often needed. This can be achieved by the use of an automatic sample changer or a fast furnace or a combination of both.

The LFA 467 *HyperFlash*® offers such a combination in the form of four individual fast-responding mini-tube furnaces for a total of four specimens (figure 2). These are arranged in a square at the same level and are characterized by superior stabilization behavior. Each mini-tube furnace has its own thermocouple; this design offers a homogeneous temperature distribution across all samples, which is beneficial for determination of the specific heat (c_p). In addition, the surrounding area is water-cooled and the entire furnace system has a low thermal mass. The combination of these specific features not only guarantees high sample throughput, but is also a prerequisite for short measurement times.

2 Four separate mini-tube furnaces of the LFA 467 *HT HyperFlash*®

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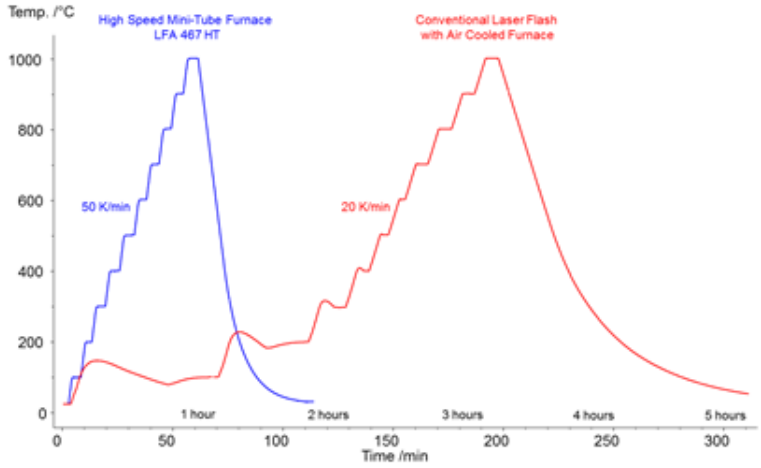


3 Comparison of LFA measurements between mini-tube furnace with water cooling and standard air cooling: throughput

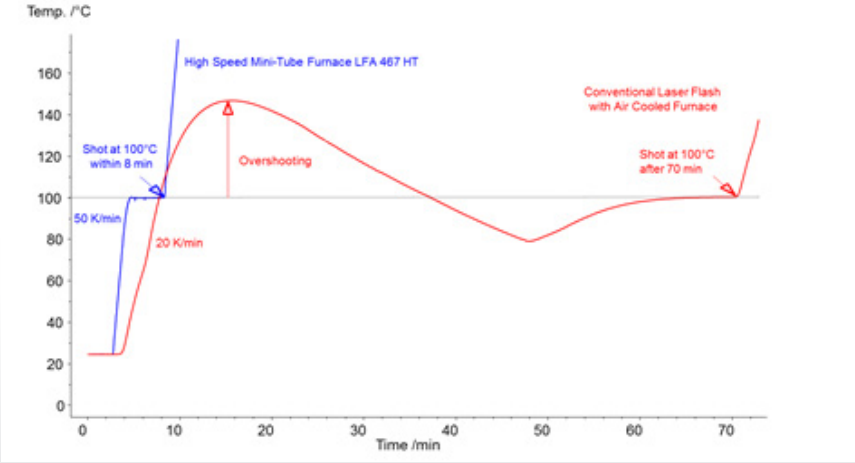
Measurement Conditions and Results

- Sample: Pyroceram (Ø 12.7 mm; 2.5 mm thick)
- T range: 25°C → 1000°C → 30°C in steps of K
- Heating rate: 50 K/min (maximum heating rate)
- Atmosphere: Argon
- Shots: 1 shot per temperature step
- Stability criteria: 0.3 K/20 s
- ΔT: 3 K

The following example demonstrates the advantages of the LFA 467 *HT HyperFlash*® over LFA systems with a conventional air-cooled furnace.

The comparison in figure 3 clearly shows that the stabilization time of the high-speed mini-tube furnace with water cooling is nearly three times faster. This goes hand-in-hand with a higher sample throughput. Within six hours, the LFA 467 *HT HyperFlash*® is able to measure 12 specimens (four samples at the same time) at temperatures of up to 1000°C. Conventional LFA systems with air cooling – even those with larger ASC capabilities – exhibit difficulties in achieving such high throughput due to poor stabilization behavior.

Figure 4 depicts the very fast stabilization time of the LFA 467 *HT HyperFlash*® compared to a conventional system. By applying the maximum heating rate of 50 K/min up to the



4 Comparison of LFA measurements between mini-tube furnace with water cooling and standard air cooling: stabilzation time

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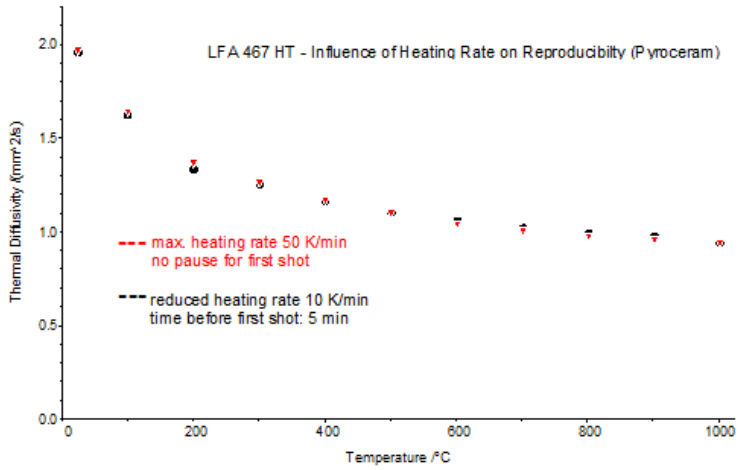


5 Comparison of LFA measurements at different heating rates

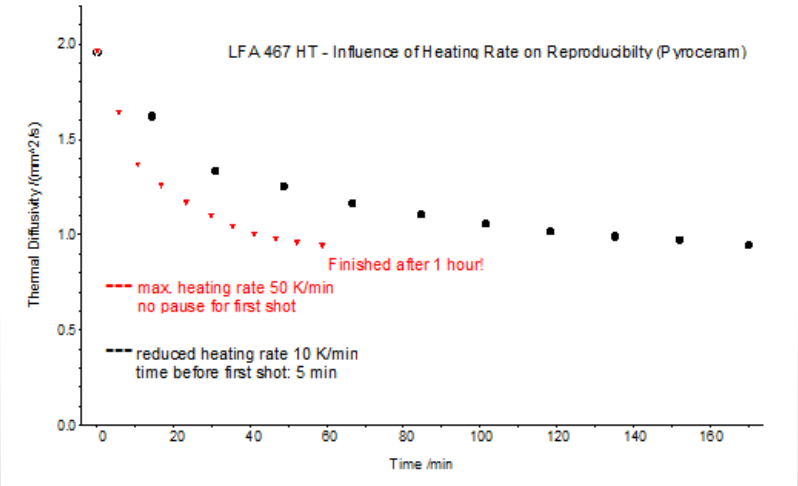
first temperature step at 100°C, the first shot can be carried out within 8 min. In contrast with the conventional furnace with air cooling, the low thermal mass of the 4-mini-tube furnace system exhibits no overheating and an extremely short stabilization time.

A comparison of the thermal diffusivity results obtained via measurements on Pyroceram at different heating rates demonstrates the high reproducibility which can be achieved – even when using the maximum heating rate of 50 K/min (figure 5).

The low stabilization time of the high-speed 4-mini-tube furnace system and the resulting ability to apply the LFA shots without intermission allows for very fast testing times. Figure 6 plots the thermal diffusivity results against time. At a heating rate of 50 K/min, the measurement was completed after only 60 min – whereas testing time increased to 170 min at a heating rate of 10 K/min.

Conclusion

The mini-tube furnaces of the LFA 467 *HT HyperFlash*® feature excellent stabilization time, which allows for measurements at an accelerated tempo. This makes the 4-mini-tube furnaces to a high-speed system which can be operated at the highest of heating rates without experiencing a loss in reproducibility and accuracy. The high testing speed even allows for faster throughput than is enabled by systems with automatic sample changers for more than 4 samples.



6 Comparison of the duration of LFA measurements at different heating rates

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