APPLICATION**NOTE**

Energy Storage Systems – Laser Flash Analysis

From Powder to Pellets: LFA Analysis of Solid Salts for Energy Storage

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Introduction

Ionic compounds such as sodium nitrate ($NaNO_3$) and sodium nitrite ($NaNO_2$) are important materials for the development of energy storage systems. In addition to their behavior in the molten state, their thermal characterization in the solid state is also of technical interest – for example, for solid-state thermal energy storage, for start-up and shut-down phases of storage systems below the melting point, and for evaluating structural transformations in the crystal lattice that can influence material properties.

Laser flash analysis (LFA) is well suited for determining thermal diffusivity. In this method, the front side of a disk-shaped sample is heated by a short laser or light pulse, and the temperature rise on the rear surface of the sample is recorded over time using an infrared detector. The thermal diffusivity of the sample is calculated from the time-dependent profile of this temperature rise. LFA is a contact-free, fast, and well-established method for determining thermophysical properties over a wide temperature range for many classes of materials – from metals and ceramics to powders and pellets.

Measurement Conditions

The salt powders $NaNO_3$ and $NaNO_2$ were pressed into pellets at 25 kN for 30 minutes in order to obtain suitable samples for LFA measurement. The measurement conditions are detailed in Table 1.

Table 1 Measurement conditions

Parameter	**Value**
Sample	$NaNo_3$ / $NaNO_2$
Instrument	LFA 717 *HyperFlash*®
Detector	InSb
Sample holder	Ø 12.7 mm, standard
Temperature range	25°C to 250°C
Sample dimensions	Ø 12.5 mm, ↕ 2 mm
Heating rate	10 K/min
Calculation model	Standard

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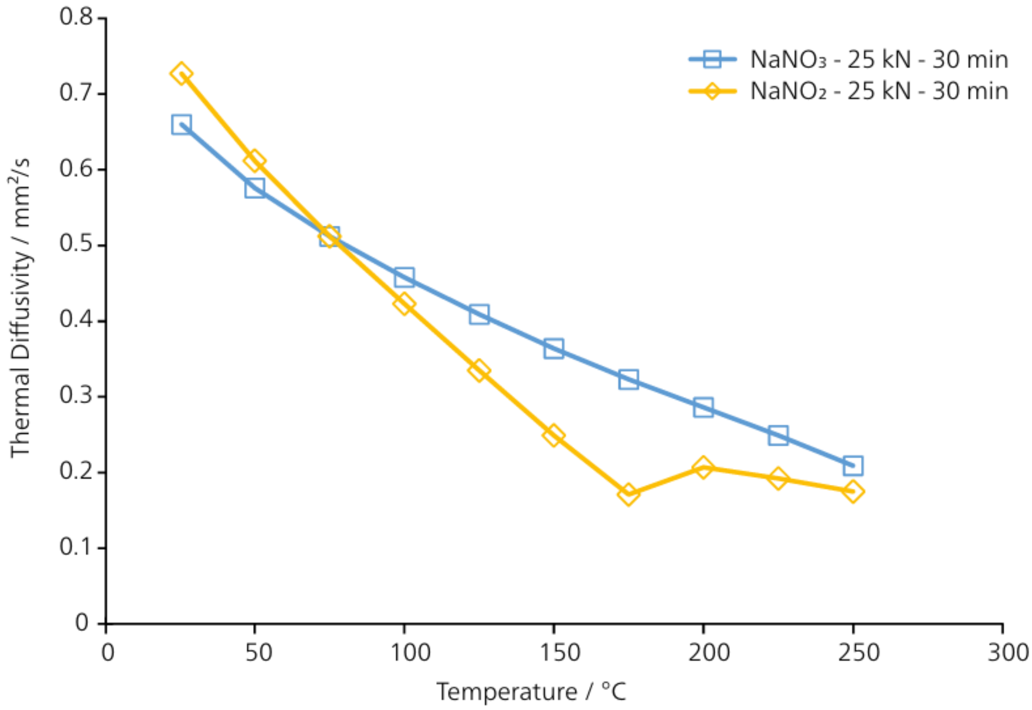

1 Thermal diffusivity of $NaNO_3$ and $NaNO_2$ (solid) as a function of temperature.

Measurement Results

The thermal diffusivity of both samples decreases with increasing temperature, which is expected for most crystalline solids due to increasing phonon-phonon interactions at higher temperatures. $NaNO_2$ additionally exhibits a local minimum at approximately 175 °C. This indicates a solid-solid phase transition in the crystal lattice of $NaNO_2$. $NaNO_3$ shows no comparable anomaly within the investigated temperature range.

Summary

The measurements demonstrate that the LFA 717 *HyperFlash®* can be used to reliably determine the thermal diffusivity of solid salts such as $NaNO_3$ and $NaNO_2$ over a wide temperature range with minimal sample preparation effort. The method requires only small sample quantities, provides measurement results within a few seconds per temperature point, and therefore enables efficient investigation of complete temperature profiles.

Furthermore, the example of $NaNO_2$ shows that LFA can be used not only for the direct determination of thermal diffusivity, but also for the indirect detection of solid-state phase transitions: anomalies in the curve progression, such as the observed local minimum, provide valuable indications of structural changes in the material that are relevant for material selection and design in energy storage applications. The combination of high measurement speed, low sample requirement, and broad material compatibility makes LFA an efficient complement to classical thermal analysis methods such as DSC.

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