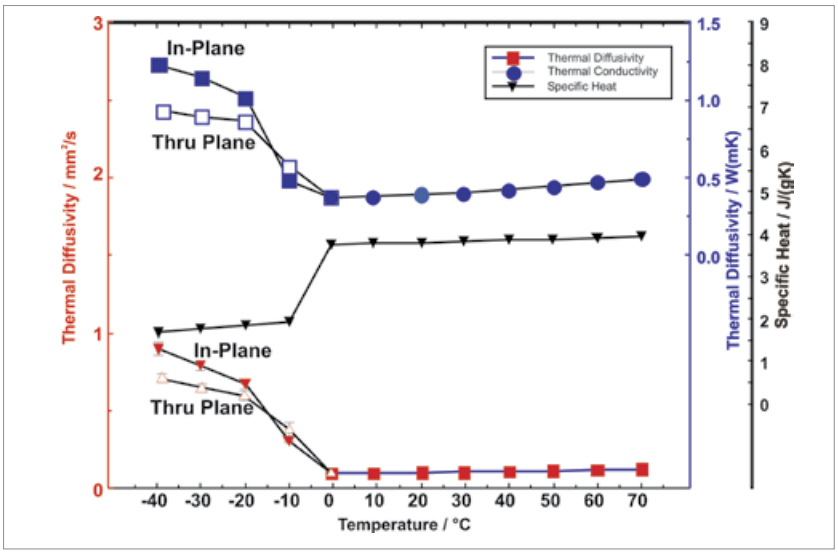
APPLICATION**SHEET**

ORGANICS – FOOD INDUSTRY

LIQUID SAMPLE HOLDER – LEAF SPINACH

Spinach has a high nutritional value and is extremely rich in antioxidants. It is a rich source of vitamin A (and lutein), vitamin C, vitamin E, vitamin K, magnesium, manganese, folate, iron, vitamin B2, calcium, potassium, vitamin B6, folic acid, copper, protein, phosphorus, zinc, niacin, selenium and omega-3 fatty acids. A fundamental importance has the cooling speed (quick-freeze) to save the nutritional value during freezing. In addition the efficiency of the production process can be increased by reduced cooling times. The needed cooling time is depending on the Biot number (Bi α = * l_{ch} / λ) which is defined as ratio of heat exchange ability and heat storage ability with α as heat transfer coefficient, lch as characteristic length for internal heat transfer and λ as thermal conductivity. Using the Biot number, a direct prediction of the needed cooling time is possible. The thermal conductivity can be measured by using an Laser Flash system. This application sheet contains the results of LFA measurements on frozen leaf spinach during and after melting up to 70°C. In the frozen state, thru-plane and in-plane measurements were carried out to investigate the influence of the alignment of the leaf layers.



Instrument

LFA 457 *MicroFlash®*

Test Conditions

Temperature range	-40 ... 70°C
Sample holder	standard and Al/SS for liquids
Sample thickness	0.506 mm
Sample surface preparation	-
c_p from DSC, standard	sapphire

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Results

In the measured apparent specific heat, the melting process can be seen as an overlapping endothermic effect. The specific heat without the energetic effect was determined by an interpolation process. The thermal diffusivity decreases from -40°C up to the melting range. Within the melting range, a step is visible due to the dissolution of the lattice structure and the loss of phonon heat transfer. Significant differences were detected for the different measurement directions due to the influence of the alignment of the leaf layers. Above the melting range, the typical linear increase for water-based liquids was detected for the thermal diffusivity and conductivity. The example clearly demonstrates that the LFA 457 can analyze the anisotropy of frozen foods as well as the properties after melting without any problems.

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