

APPLICATION**NOTE**

Epoxy Resin – TCT/GHFM

Controlled Adjustment of the Thermal Conductivity of Epoxy Resins – Boron Nitride Fillers Characterized with the TCT 716 *Lambda*

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Introduction

Epoxy resins (EP) are among the most important polymeric materials used in electronics, lightweight construction, coatings, and fibre-reinforced composites. They are characterized by excellent mechanical properties, high chemical resistance, and good processability. However, their inherently low thermal conductivity can limit their use in applications that require effective thermal management.

Adding thermally conductive fillers such as boron nitride (BN) can significantly enhance thermal conductivity. This is particularly important for electronic components, potting compounds, thermal management systems, and composites exposed to high thermal loads. The reliable determination of thermal conductivity is therefore essential for the development and optimization of such materials.

Measurement with the TCT 716 *Lambda* Using the GHFM Method

The NETZSCH TCT 716 Lambda was used to characterize the thermal conductivity of the materials. The instrument enables precise, direct measurement of thermal conductivity in polymers, composites, and other solids over a broad temperature range.

The measurement principle is based on the Guarded Heat Flow Meter (GHFM) method. A defined heat flux is passed through the sample, and the resulting temperature difference is measured. An additional controlled guard heater minimizes lateral heat loss, helping to ensure high measurement accuracy and excellent reproducibility. The measurement parameters are summarized in Table 1.

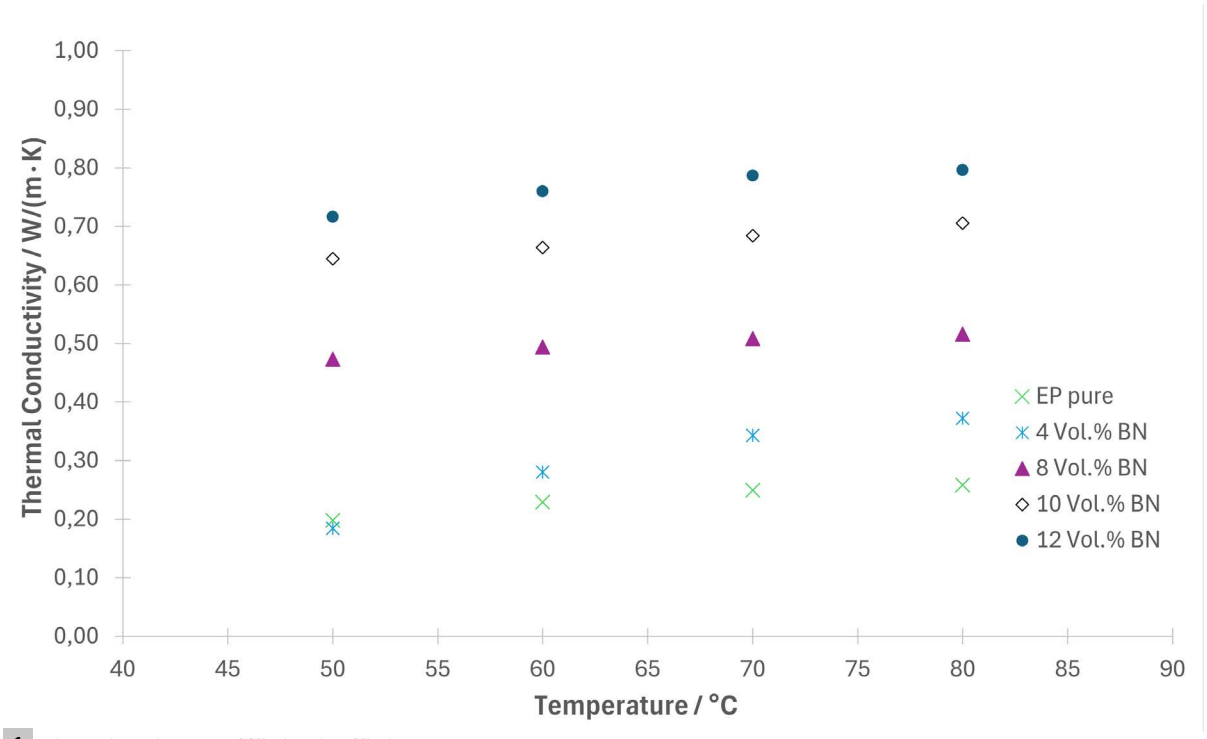
Table 1 Measurement conditions

Measuring instrument	TCT 716 *Lambda*
Method	GHFM
Samples	Unfilled epoxy resin and epoxy resin filled with BN
Sample sizes	Ø approx. 51 mm; thickness 2 to 6 mm; plane parallel
Temperature range	50°C to 80°C in steps of 10 K
Calibration	Fused silica

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1 Thermal conductivity of filled and unfilled epoxy resin

Measurement Results

As shown in Figure 1, the thermal conductivity of the epoxy resin increases significantly with increasing boron nitride content. While the unfilled material exhibits values of approximately 0.20 to 0.26 W/(m·K), the addition of 8 vol.% BN increases thermal conductivity by up to 140%. At 10 vol.% BN, the increase reaches up to 230%, while 12 vol.% BN yields an improvement of up to 280% compared with the unfilled reference material. In addition, all compositions show a slight increase in thermal conductivity with increasing temperature. These results demonstrate the effectiveness of boron nitride as a filler for enhancing the thermal conductivity of epoxy resins.

Summary

The measurements clearly demonstrate that the thermal conductivity of epoxy resins can be systematically tailored and significantly increased by adding boron nitride. Even moderate concentrations of the filler lead to a substantioanl improvement in thermal conductivity, opening up new possibilities for thermally demanding applications.

In this context, the NETZSCH TCT 716 *Lambda* provides a reliable solution for material characterization. Its precise GHFM technology enables the precise and reproducible determination of thermal conductivity, even for low-conductivity polymers and filled composites. Consequently, the TCT 716 *Lambda* is a powerful tool for the research, development and quality control of modern thermal management materials.

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