APPLICATION**NOTE**

Polymers – GHFM Method

Precise Measurement, Differentiated Evaluation: Thermal Behavior of PPS with and without Fillers

Fabia Beckstein, Applications Laboratory Selb, and Jinyan Lin, Applications Laboratory Shanghai

Introduction

Polyphenylene sulfide (PPS) is a high-performance thermoplastic polymer that is used in demanding technical applications due to its high thermal and chemical resistance as well as its dimensional stability. PPS plays a central role in the manufacture of thermally and mechanically stressed components, particularly in the automotive, electronics and aerospace industries. Comprehensive knowledge of thermal conductivity is crucial for the thermal design and thermal management of such components. It enables precise modeling of heat flows and prevents local overheating, all of which in turn increases the operational safety and service life of the systems.

GHFM Method

The TCT 716 *Lambda*, which functions according to the GHFM (guarded heat flow meter) method, can carry out a straightforward characterization of polymers thanks to its ability to measure thermal conductivity directly. Even small changes in the chemical composition, due to the addition of fillers, can be detected.

Measurements

Tables 1 and 2 describe both the PPS samples tested and the measurement conditions. Samples of pure and modified PPS (glass fiber + carbon black) were available. All samples were analyzed using the TCT 716 *Lambda*.

Table 1 Samples

Sample	Pure PPS	Filled PPS
Number	2	2
Thickness	4 and 5 mm	4 and 5 mm
Diameter	Approx. 51 mm	Approx. 51 mm

Table 2 Measurement parameters

Temperature program	25 - 200°C in 25-K steps
Temperature gradient	30 K
Pressure	175 kPa
Calibration material	Vespel Sp1

NGB · Application Note 390 · DE · 0725 · Technical specifications are subject to change.

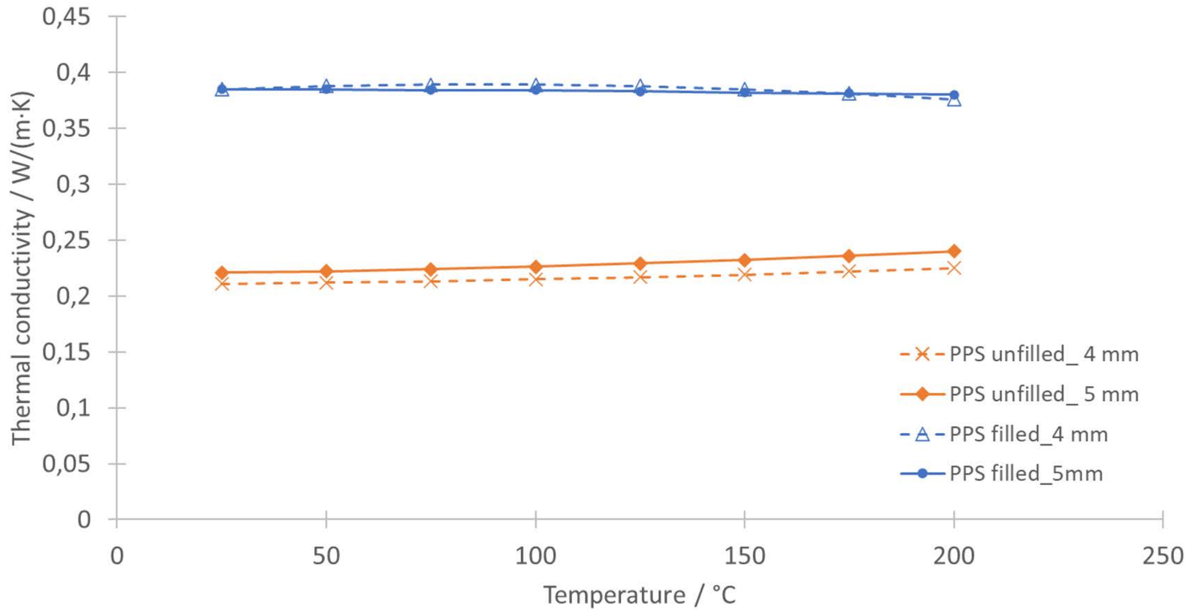
NETZSCH-Gerätebau GmbH
Wittelsbacherstraße 42 · 95100 Selb · Germany
Phone: +49 9287/881-0 · Fax: +49 9287/881505
at@netzsch.com · www.netzsch.com

NETZSCH

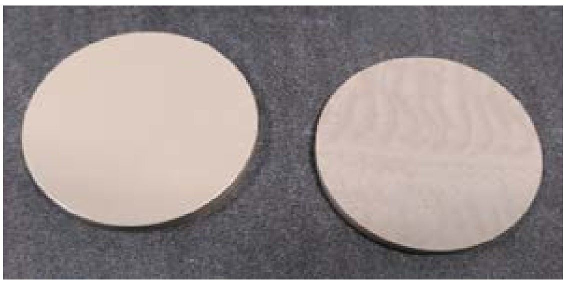
Results and Discussion

Figure 1 provides an overview of the thermal conductivity measurements obtained from both filled and unfilled PPS samples. The orange measurement curves show the results of the thermal conductivity tests for the samples made of pure PPS, while the blue measurement curves represent the results for the filled samples. As expected, the filled samples exhibit a significantly higher thermal conductivity (approx. by a factor of 1.75) than the pure PPS. The results for the filled samples are nearly identical.

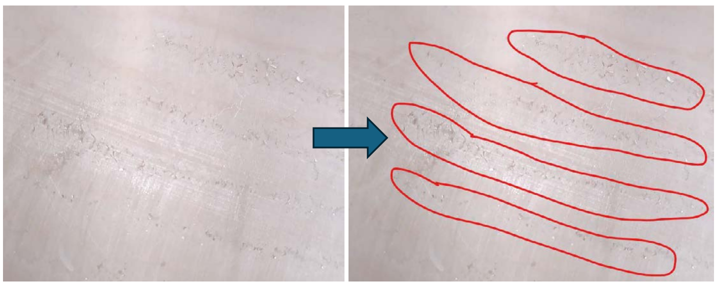
In the case of the samples made of pure PPS, the 4-mm sample has a slightly lower thermal conductivity (difference of approx. 6.3%). This is probably due to structural differences between the two samples. The 4-mm sample appears to have an inhomogeneity (see figure 2) which, on closer inspection, could be linked to pores within certain areas of the material (see figure 3). This structural inhomogeneity probably originates from the manufacturing process. Pores normally lead to a reduction in thermal conductivity, which is confirmed by the results of the TCT measurements.



1 Thermal conductivity of filled and unfilled PPS between 25 and 200°C measured with the TCT 716 *Lambda*.



2 Pure PPS, 5 mm (left) and 4 mm (right), with inhomogeneity (pores in the light parts).



3 Inhomogeneous pure PPS – slightly porous in the light areas; not porous in the dark areas

NETZSCH-Gerätebau GmbH
Wittelsbacherstraße 42 · 95100 Selb · Germany
Phone: +49 9287/881-0 · Fax: +49 9287/881505
at@netzsch.com · www.netzsch.com

Summary

The TCT 716 *Lambda* enables direct measurement of the thermal conductivity of polymers and offers high effectiveness in analyzing thermal property differences between pure polymer matrices and filler-reinforced polymers. It also reliably detects subtle variations caused by structural changes resulting from different manufacturing processes.

In addition, the TCT 716 *Lambda* features two independent test stacks, allowing for faster data collection and higher throughput – an important advantage for quality control in industrial environments.

NETZSCH-Gerätebau GmbH
Wittelsbacherstraße 42 · 95100 Selb · Germany
Phone: +49 9287/881-0 · Fax: +49 9287/881505
at@netzsch.com · www.netzsch.com

NETZSCH