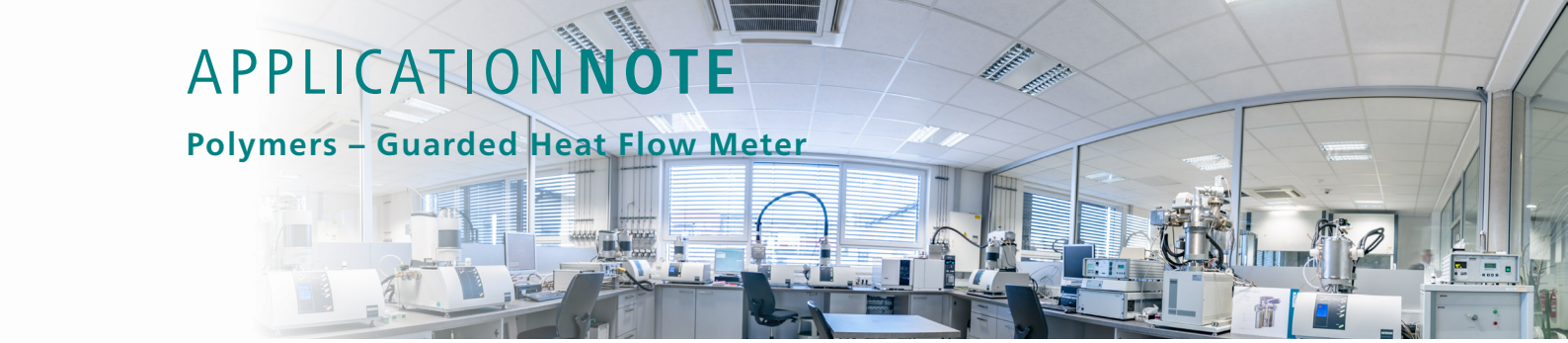


Accurate Thermal Conductivity Determination of PMMA by the Guarded Heat-Flow Meter

Brad Hammond, Applications Laboratory Burlington, MA, USA

Introduction

Polymethyl methacrylate (PMMA), commonly referred to as acrylic glass or by trade names such as Plexiglas® or Perspex®, is a transparent thermoplastic known for its optical transparency, stiffness, rigidity, shatter resistance, durability, and low density. These characteristics make it an ideal material, frequently used as a glass alternative, for a wide range of applications in optics, electronics, automotive, marine, aerospace, and construction industries. Given its extensive use in various industries, understanding PMMA's thermal behavior is essential for ensuring safety, optimizing thermal management, and improving design, performance, and manufacturing processes.

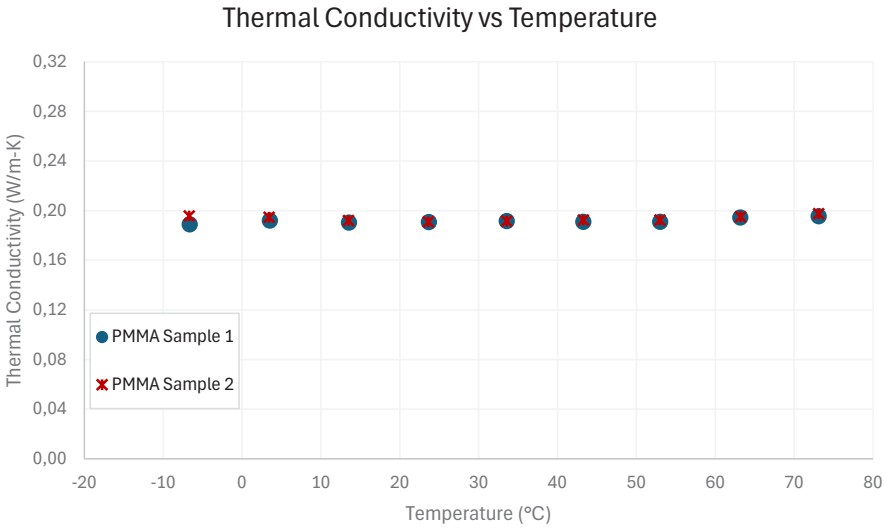
Experimental

Two PMMA samples were tested using the TCT 716 *Lambda*® Guarded Heat Flow Meter (GHFM) following the method described in ASTM E1530. This steady-state method involves placing a sample of known thickness between two plates maintained at different temperatures, allowing heat to flow through the sample. The heat flow through the sample's thickness is then measured, and thermal conductivity is calculated.

The two specimens were tested across a temperature range of -10°C to 70°C in 10°C intervals. Each test specimen had a diameter of approximately 51 mm, a thickness of 3 mm, and a density of 1.18 g/cm^3. Calibration was performed using Vespel® SP-1. The samples were tested under a load of 175 kPa, and a thin layer of thermal paste was applied to reduce contact resistance.

Results and Discussion

The thermal conductivity of PMMA over the measured temperature range of -10°C to 70°C was approximately 0.19 W/(m·K), increasing slightly to 0.20 W/(m·K) within this range. Both PMMA samples were tested three times across this range, demonstrating good repeatability between measurements; an average relative standard deviation of 1% throughout the entire temperature range was observed.



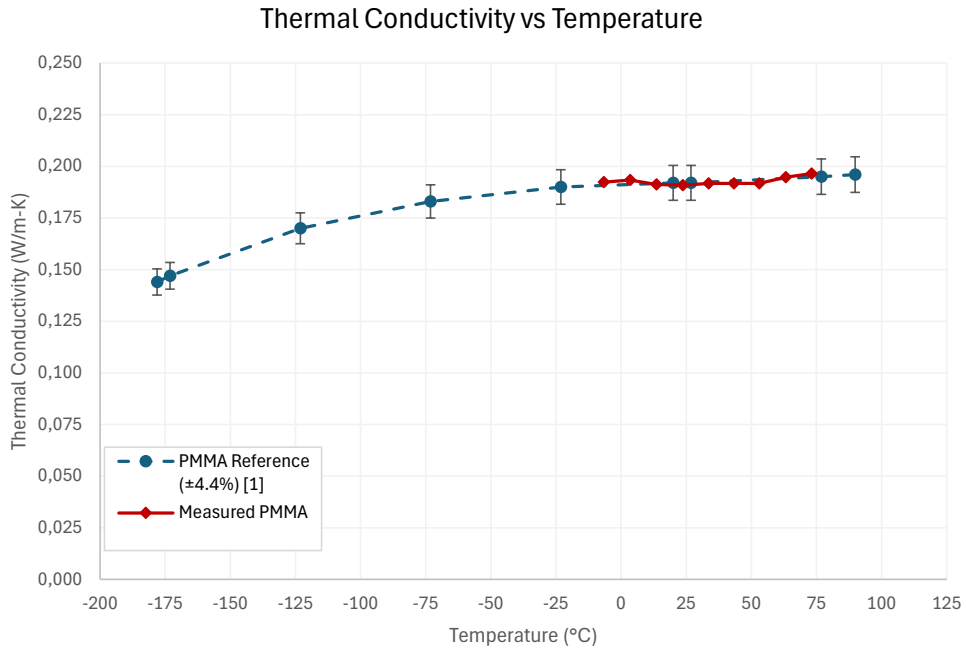
1 Measured thermal conductivity of PMMA Samples 1 and 2. The reported values are an average of triplicate measurements on each sample.

The data presented in Chart 1 represents the average of these triplicate measurements. It is evident that the thermal conductivity exhibits a nearly linear trend over this temperature range, and the agreement between the two separate test samples is excellent.

NGB · Application Note 371 · EN · 0425 · 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



2 Averaged values of PMMA Samples 1 and 2 ('Measured PMMA'; red curve) compared with literature reference values [1].

Thermal conductivity values for PMMA are available in various literature sources. Typically, literature values report the thermal conductivity of PMMA at room temperature to be around 0.19 W/(m·K). Antoniadis et al. have compiled numerous literature sources and developed a recommended dataset for PMMA over the temperature range of -178°C to 90°C [1]. The thermal conductivity results from this study (average of PMMA Samples 1 and 2) are plotted in Chart 2, together with the reference values from Antoniadis et al. It is clear that the data presented here aligns extremely well with the reference values.

Summary

The thermal conductivity of PMMA was measured between -10°C and 70°C using the TCT 716 *Lambda*® Guarded Heat Flow Meter. The conductivity ranged from 0.19 W/(m·K) to 0.20 W/(m·K), showing a slight increase with temperature. The measured values closely matched the reference data from literature [1], confirming that the TCT 716 *Lambda*® provides accurate and reliable measurements of PMMA's thermal conductivity, an essential property in understanding the material's thermal characteristics.

References

[1] Antoniadis, Konstantinos & Tyrou, Alexandra & Assael, Marc & Li, Xiaojing & Wu, Jiangtao & Ebert, Hans-Peter. (2020). Reference Correlations for the Thermal Conductivity of Solid BK7, PMMA, Pyrex 7740, Pyroceram 9606 and SS304. International Journal of Thermophysics. 41. 10.1007/s10765-020-02678-9.

NGB · Application Note 371 · EN · 0425 · 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