Thermal Characterization of Silicone

Claire Strasser and Dr. Stefan Schmölzer

Introduction

We encounter silicones, also called polysiloxanes, every day without even noticing them. For example, silicone rubbers protect car electronics from moisture and contamination, in washing machines they prevent the suds from foaming over, in shampoos they give hair a silky shine, and as silicone resin paints they keep masonry water-repellent while at the same time being permeable to water vapor and carbon dioxide from the interior. But silicones are also found in other applications that require high resistance, such as in medical technology as a pure material in medical tubes, wound pads or orthopedic products, and in electrical equipment as safe sealing and insulation materials.

Silicone are long-chained molecules containing O-Si bonds. Dependent on their molecular mass and their degree of curing, they can be found as liquids, gels or elastomers [1, 2]. This wide variety of polysiloxanes is associated with very different properties, so it is important to characterize them.

DSC Measurement Parameters

DSC is particularly appropriate for analyzing the behavior of silicones at low temperatures. In the following, the thermal properties of a silicone material are determined. To this end, a DSC measurement is carried out, as described in table 1.

Table 1 Measurement Conditions

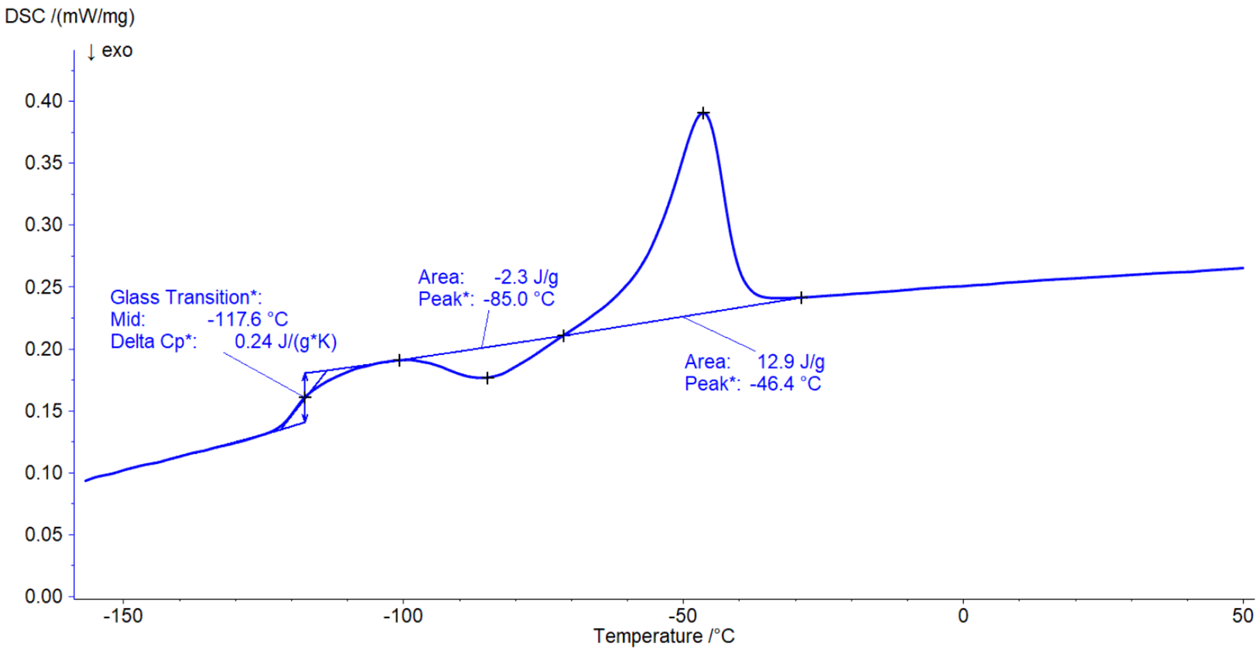
Device	DSC 300 *Caliris*®, P-Module
Sample mass	8.75 mg
Crucible	*Concavus*® (aluminum) with pierced lid
Temperature range	-170°C to 100°C
Heating rate	10 K/min
Atmosphere	Nitrogen (40 ml/min)

NGB · Application Note 281 · EN · 0523 · 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

Measurement Results

Figure 1 depicts the resulting DSC curve. The endothermic step detected at -117.6°C (mid-point) is due to the glass transition of the material. It is associated with a change in specific heat capacity of 0.24 J/(g·K). Between -100°C and -30°C, two different effects take place. Firstly, the exothermal peak occurs at -85.0°C, which is a post-crystallization effect. This occurs above the glass transition temperature, when the polymer chains are capable of moving freely and can therefore crystallize. Secondly, with increasing temperature, the endothermic peak detected at -46.4°C represents melting of the crystalline phase.



1 DSC measurement on silicone

Summary

Silicone can withstand high temperatures well due to its material properties. Therefore, it can also be used for different applications in a wider temperature range. However, the DSC investigation shows that these results are crucial for the application range of this material at low temperatures: It will behave very differently at room temperature as compared to a temperature below the melting effect or glass transition.

Sources

[1] Biomedical polymers, ROBERT G. HILL, Biomaterials, Artificial Organs and Tissue Engineering, 2005

[2] Polymers, Inorganic and Organometallic, Martel Zeldin, https://www.sciencedirect.com/referencework/9780122274107/encyclopedia-of-physical-science-and-technology

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