Friedrich-Alexander-Universität
Erlangen-Nürnberg

LEHRSTUHL
FÜR KUNSTSTOFFTECHNIK
Prof. Dr.-Ing. Dietmar Drummer

Highly Filled Polymers

Motivation

Pure plastics are characterized by high electrical insulating and low thermal conductivity. At the same time they show limited mechanical properties, high thermal expansion and bad flaming behavior. These factors may restrict the operation area of plastics.

By the use of different fillers e.g. thermal and electrical conductivity, flammability, mechanical and magnetic properties can be tailored to match the applications requirements. In addition to the type of filler, the filler concentration also has a major influence on the properties of the plastics (Fig. 1). However, an increase in filler content is accompanied by an embrittlement of the material.

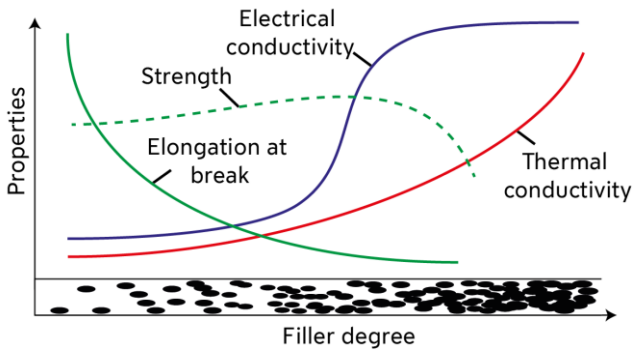

Fig. 1: Influence of filler degree on different material properties

Application

Due to their low densities and the flexible manufacturing process of injection molding plastics are used in multiple applications. Often they are used as housings of electrical components. Besides the protection of the encapsulated components the enclosure must also ensure adequate heat dissipation to protect the components from overheating. By the use of thermal conductive fillers (different types and geometries; Fig. 2) the heat transfer can be increased dramatically. This allows either a higher power consumption or a miniaturization of the whole component.

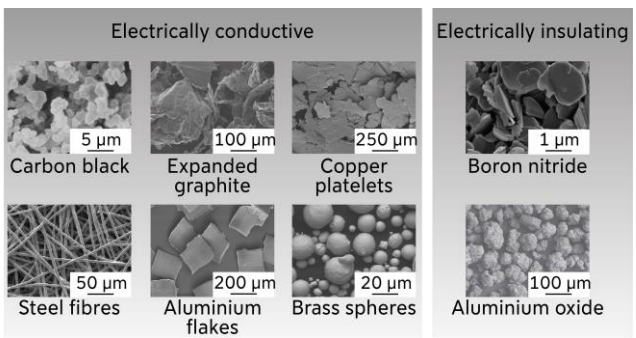

Fig. 2: Overview of various thermal conductive fillers with differing shapes and sizes

| Institute of Polymer Technology
| Am Weichselgarten 10 | 91058 Erlangen-Tennenlohe, Germany
| Phone: +49 9131 85 710 00 | Fax: +49 9131 85 710 07
| Mail: lkt-info@fau.de | https://www.lkt.tf.fau.eu/

Research focus

However, a differentiation between electrical conducting and insulating fillers is necessary. If the component requires electrical insulation, only the use of non conducting fillers is possible. If the an electrical conductivity is irrelevant, the use of electrical conducting fillers is advisable. Due to the higher thermal conductivity of electrical conducting fillers, the same value of thermal conductivity can be achieved with lower filler contents compared to electrical insulating fillers. As part of our research on bipolar plates, one focus is the simultaneous modification of high thermal and electrical conductivity.

As displayed in Fig. 2 different filler geometries are available. Especially anisometric fillers (e.g. fibers or platelets) may be orientated during the processing resulting in significant differences of properties (thermal, electrical and mechanical) in various directions (Fig. 3).

Main research results

By the use of fillers a modification of material properties is possible. With a simultaneous combination of different fillers an additional increase of a single desired material property or the forming of an entire property profile is possible.

In case of extremely high filler contents (up to 80 wt.-%) of graphite not only the thermal but also the electrical conductivity is strongly increased (Fig. 4).

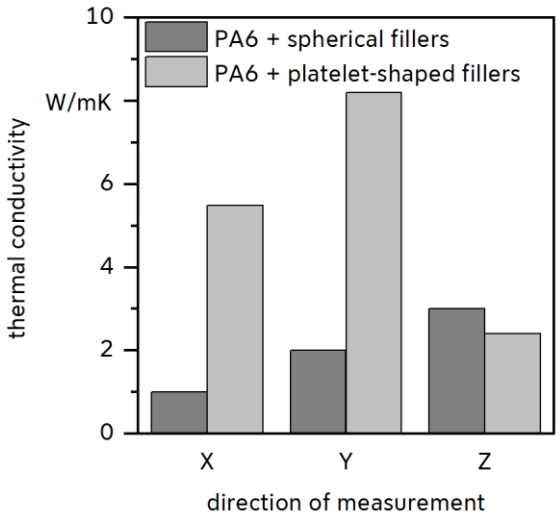

Fig. 3: Influence of filler shape on the thermal conductivity in differing directions

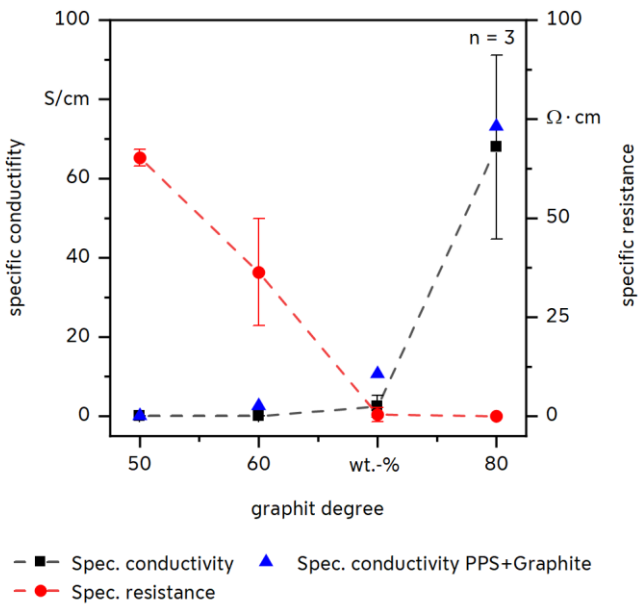

Fig. 4: Influence of electrical conductive filler on conductivity and resistance

| Institute of Polymer Technology
| Am Weichselgarten 10
| 91058 Erlangen-Tennenlohe, Germany
| Phone: +49 9131 85 710 00
| Fax: +49 9131 85 710 07
| Mail: lkt-info@fau.de
| https://www.lkt.tf.fau.eu/