APPLICATION NOTE

Elastomers – Thermogravimetry

Composition of a Bicycle Tire Casing

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Introduction

Many people consider a bicycle to be an indispensable means of transportation. The tire is an elementary component and at the same time, a decisive influential factor on the riding characteristics. It can be adapted to suit the ground and desired riding quality qualities.

Basically, a bicycle tire casing consists of a composite of different materials. This composite combines the flexibility and tribological properties of a rubber compound (tread) with the strength of a synthetic polymer fabric (carcass) and the dimensional stability of a wire bundle (core). The rubber compound itself is made of various organic and inorganic raw materials and fillers. This composition is largely responsible for the properties of the rubber compound. [1]

Thermogravimetric analysis is a widely used analytical method for examining rubber compounds. Thermogravimetry is described in ISO 9924 and ASTM E1131 standards for this application range. Therefore, the composition of the casing of a bicycle tire is here examined using thermogravimetric analysis.

Methods and Sample Preparation

In order to obtain a measurement representative of the rubber compound of the casing, several small samples with a total mass of 10 mg were cut out of the casing profile. Care was taken to ensure that these pieces consisted only of the rubber compound of the tread and did not include any components of the carcass or the core.

For the thermogravimetric investigation, the NETZSCH TG *Libra*® was employed. These measurements were carried out under the conditions detailed in table 1.

Table 1 Measurement conditions of the thermogravimetric investigation of a bicycle tire casing

Sample	Bicycle tire casing
Sample weight	9.79 mg
Crucible material	Alumina, open
Temperature range	40°C to 1100°C
Temperature program	40°C - 850°C in nitrogen; 805°C - 1100°C in air
Heating rate	10 K/min
Atmosphere	Nitrogen, air

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Measurement Results and Discussion

Figure 1 shows the thermal decomposition of the bicycle tire casing. The first mass loss of 8.7% (DTG peak at 283.2°C) is due to the evaporation of the plasticizer content. Then, degradation of the organic rubber components can be observed. This takes place in two clearly separate steps with the first step showing a mass loss of 25.1% and the second one a mass loss of 31.8%. The two steps can also be recognized when looking at the DTG curve with the first peak at 379.1°C and the second peak at 469.8°C.

In addition to the organic components of the tire casing, small content levels of inorganic fillers can also be seen in the TGA curve upon further heating. This loss is due to the release of CO_2 from the decomposition of $CaCO_3$ into CaO at a peak of the DTG signal at 664.5°C. Even small amounts the 1.2% in this example can be detected without any problems.

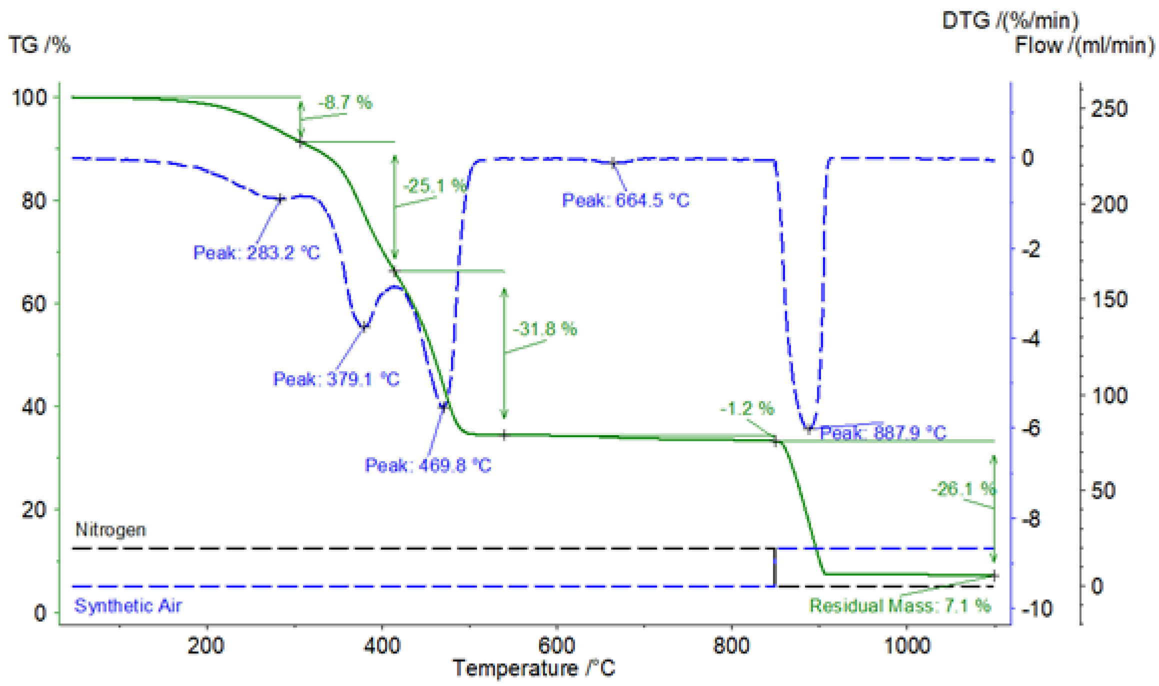
At 850°C, the atmosphere was switched from an inert nitrogen atmosphere to an oxidizing atmosphere. Due to this change of atmosphere, combustion of carbon black can be observed during heating to 1100°C, and the resulting ash content of 7.1% can be quantified.

Summary

The rubber compound of the bicycle tire casing was examined using thermogravimetric analysis. The proportion of organic ingredients, such as plasticizers and rubber, can thus be determined. Despite its low proportion, the inorganic filler content was additionally detected and the resulting ash content was determined.

Literature

[1] https://www.schwalbe.com/service/technik-faq/reifenaufbau



1 Temperature-dependent mass changes of a bicycle tire casing (green curve), rate of mass change (DTG, dashed blue curve), gas flow (nitrogen: dashed black; air: dashed blue).

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