Thermoanalytical Examinations of Noise Reducing- and Reinforcing Foams in the Automotive Industry

Autors: G. Leu, A. Schöning, Sika AG Central Analytics, Tüffenwies 16–22 CH-8048 Zürich

Introduction

Increasing demand of acoustic and safety performance has triggered to the development of SikaBaffle-250® (acoustic foam) and SikaReinforcer-911® (structural foam). The products were developed in the nineties, SikaBaffle-250® 1994 and SikaReinforcer-911® 1999 commercialized. Both are used to fill cavities in vehicle bodies. They expand (SikaBaffle-250®: 200-1200 %, SikaReinforcer-911®: 100-200 %) and cure at the same time during the heat cure cycle of the electro coating.

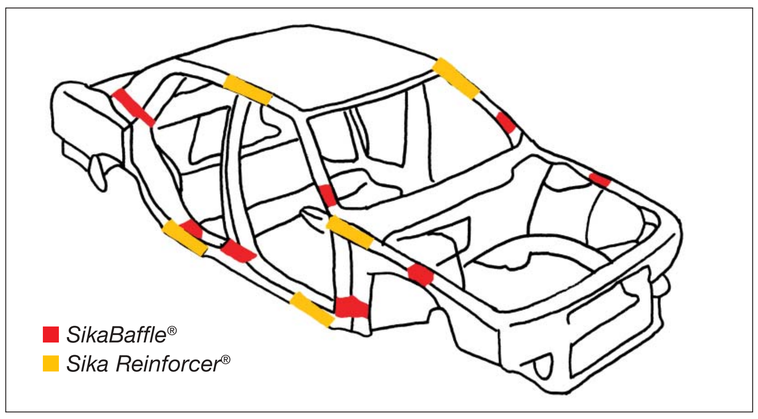
Chemistry and Function

SikaBaffle-250®:

– thermoplastic based, injection moldable product, crosslinked with epoxy resin
– foaming is chemically induced by the decomposition of an azodicarbonamide derivate and release of gases (mainly: N_2, CO)
– block and absorb noise in body cavities
– applied by most of the european and american automotive producers

SikaReinforcer-911®:

– epoxy based, injection moldable thermoset material with excellent adhesion to metals
– foaming is chemically induced by the decomposition of an azodicarbonamide derivate and release of gases (mainly: N_2, CO)
– curing of epoxy resin by dicyandiamide
– reduces weight, noise and vibrations in vehicles
– increases stiffness in vehicle body sections (for durability, more safety in crash situations)
– used by DaimlerChrysler and General Motors



Problem statement

The foams SikaBaffle-250® and SikaReinforcer-911® were analysed by using DSC to examine the melting- and reaction behaviour, by FTIR to proof the curing reaction, by TG/MS to analyse the gaseous products that are set free during expansion and by TG to get to know the beginning of the gas release and the amount of the gases what is important for the quality insurance in industry.

1. DSC

With DSC (Perkin Elmer, DSC Pyris 1) the melting- (of the thermoplastic component in SikaBaffle-250®) and the reaction behaviour (reaction of epoxy with functional group in both samples) of the materials can be characterized. The analyses - due to expansion of the samples- take all place in high-pressure crucibles. The results are shown in table 1 and 2, the DSC-curves in chart 1 and 2.

Sample	Reaction Enthalpy	Melting Enthalpy
SikaBaffle-250®	***1. run:*** **–72.8 J/g ± 1.0 J/g (range: 130–200 °C, T_{max}: 172.0°C ± 0.1)** ***2. run:*** **no negative enthalpy**	***1. run:*** **52.9 J/g ± 1.7 J/g (range: 20–130 °C, T_{min}: 77.8 °C ± 0.6)** ***2. run:*** **53.2 J/g ± 2.2 J/g (range: 20-130 °C, T_{min}: 78.9 °C ± 0.4)**

Table 1

Sample	Reaction Enthalpy	T_g
SikaReinforcer-911®	***1. run:*** **–197.2 J/g ± 1.0 J/g (range: 140–230 °C, T_{max}: 183.0°C ± 0.4)** ***2. run:*** **no negative enthalpy**	***1. run:*** **48.2 °C ± 0.7** ***2. run:*** **51.6 J/g ± 0.5**

Table 2

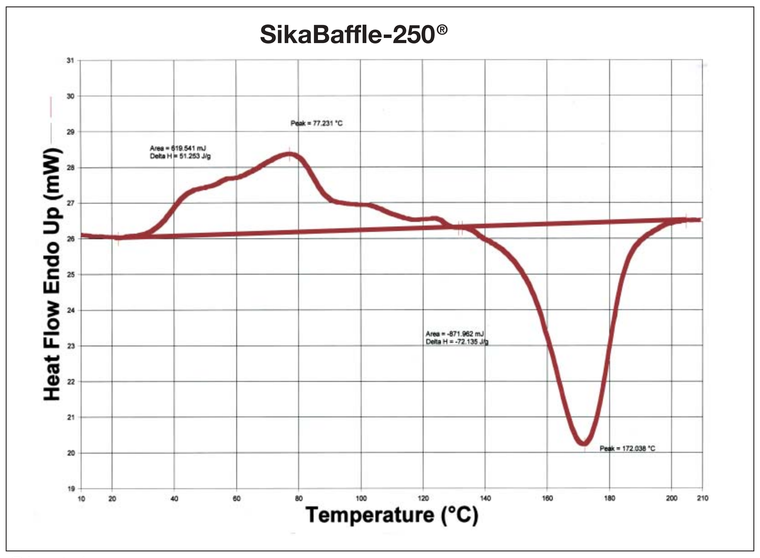


Chart 1

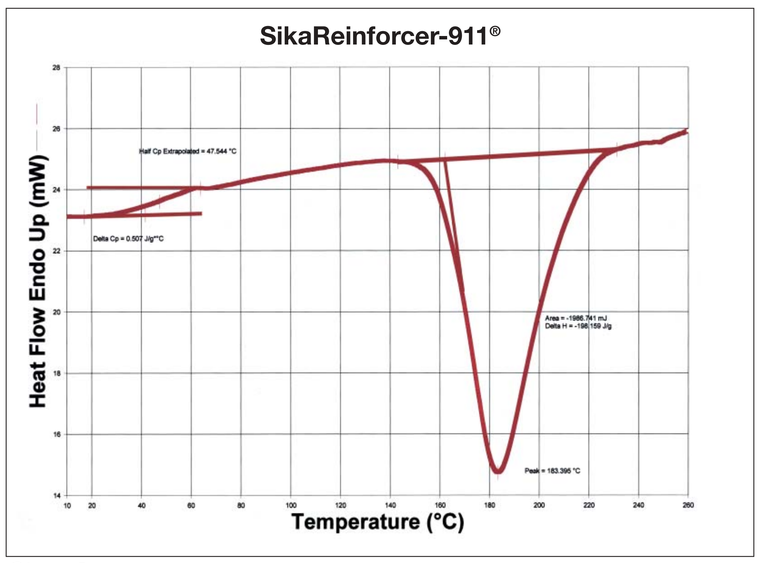
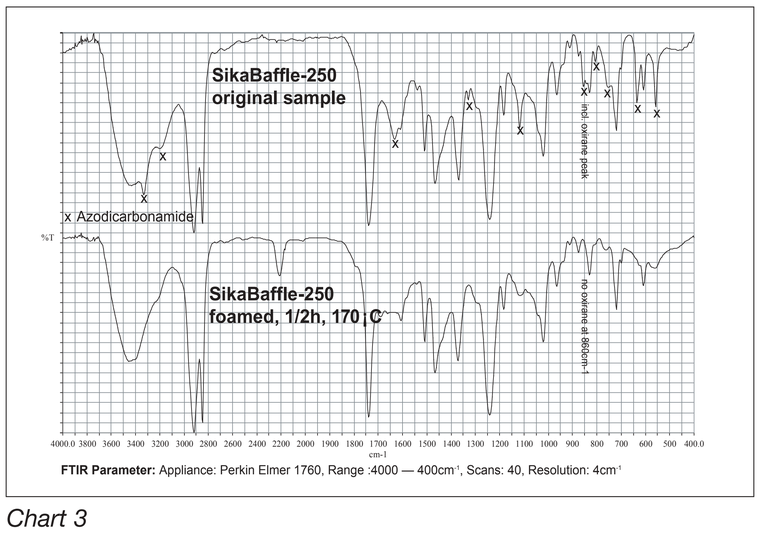


Chart 2

2. FTIR

By using FTIR (Perkin Elmer, FTIR 1760), differences between the cured and uncured samples can be examined. The typical oxiran-peak (circa 860 cm^{-1}) of the epoxy resin e.g. can be seen in the FTIR-spectra of the uncured samples. It disappears in the spectra of the cured samples, which is a proof for the reaction of the epoxy-component with a functional group. Furthermore the charakteristic peaks of Azodicarbonamide (blowing agent that decomposes) and Dicyandiamide (curing agent, reacts with epoxy resin) are also vanished in the spectra of the cured samples. The results are presented in chart 3 and 4.



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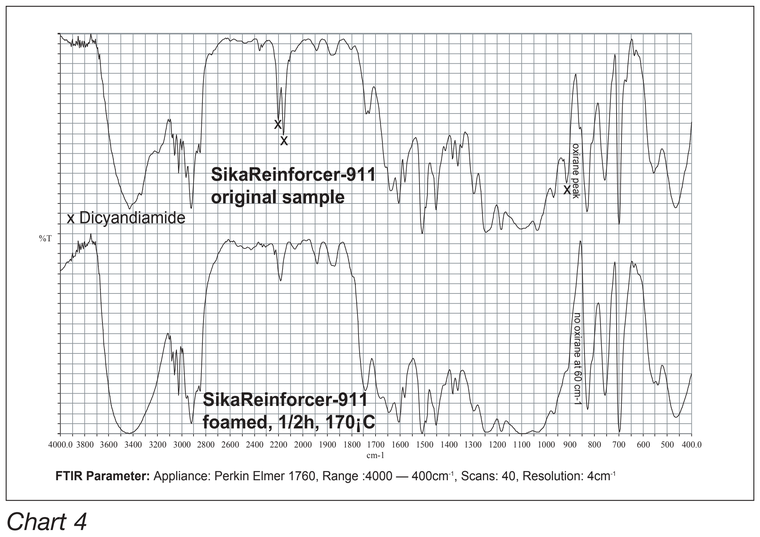

Chart 4

3. TG/MS

With TG/MS (Netzsch, STA 409) the gases generated during the expansion were detected (TGA: Dynamic analysis: 30-400°C, heating rate 10°C/min, Helium, MS: 1800 Volt, measuring time: 10 msec). The following table 3 shows the gases and chart 5 and 6 the TG-MS-curves.

Sample	Detected Gases	Weight loss (30–220 °C)
SikaBaffle-250®	**N_2, NH_3, H_2O and CH_4**	**4.6% ± 0.1**
SikaReinforcer-911®	**N_2, H_2O**	**0.8% ± 0.1**

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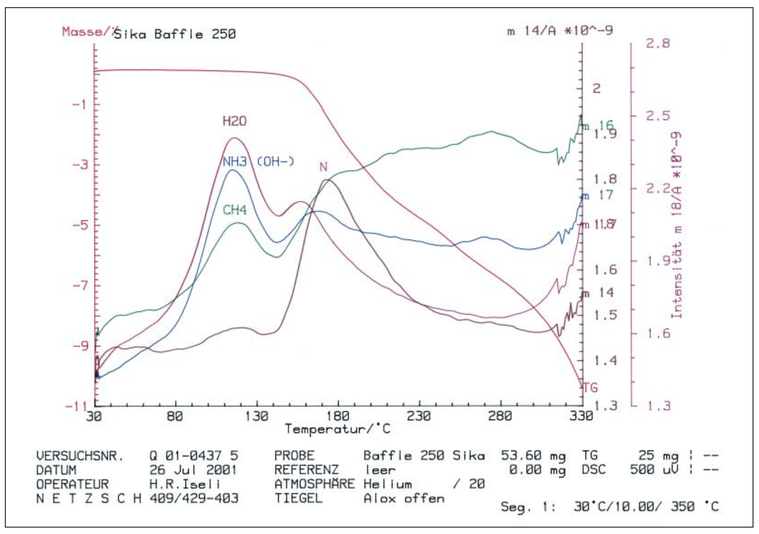

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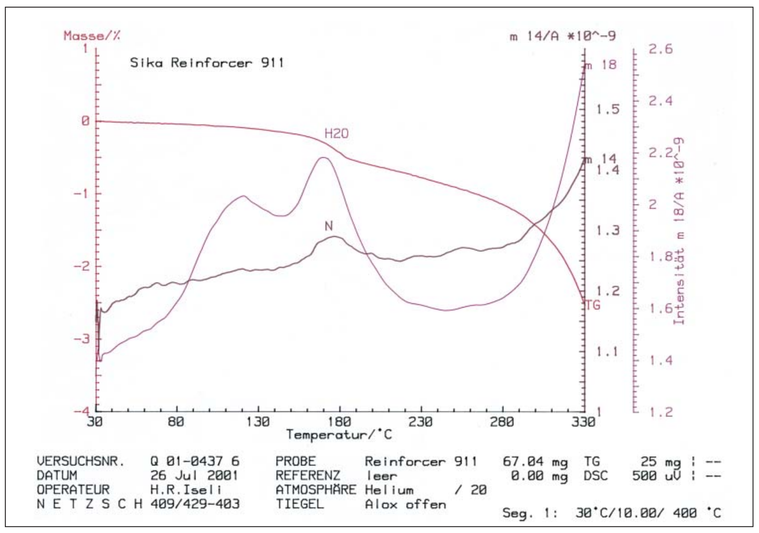

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4. TG

By using TG (Perkin Elmer, Pyris 1 TGA) the beginning of the expansion (onset temperature) of the samples and the amount of the gaseous products can be determined. The following two methodes were used:

– Dynamic analysis: The weight loss from 50-220 °C (heating rate: 40°C/min, air) and the onset temperature were examined.
– Isothermic analysis: heat to 170°C, hold for 30 min at 170°C (air).

The results are presented in table 4 and 5.

Sample	Weight loss (dynamic analysis: 50–950 °C, heating rate: 40 °C/min, air)	Onset temperature
SikaBaffle-250®	**4.3% ± 0.1**	**163.3 °C ± 0.2**
SikaReinforcer-911®	**1.0% ± 0.1**	**167.3 °C ± 0.1**

Table 4

Sample	Weight loss (isothermic analysis: 30 min at 170 °C, air)
SikaBaffle-250®	**4.8% ± 0.1**
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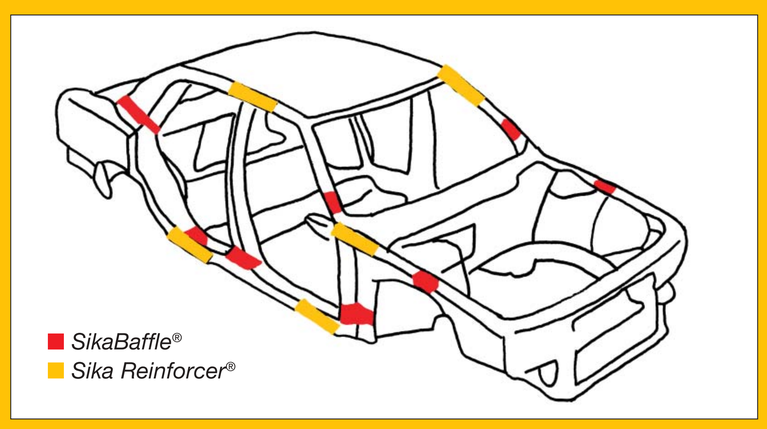

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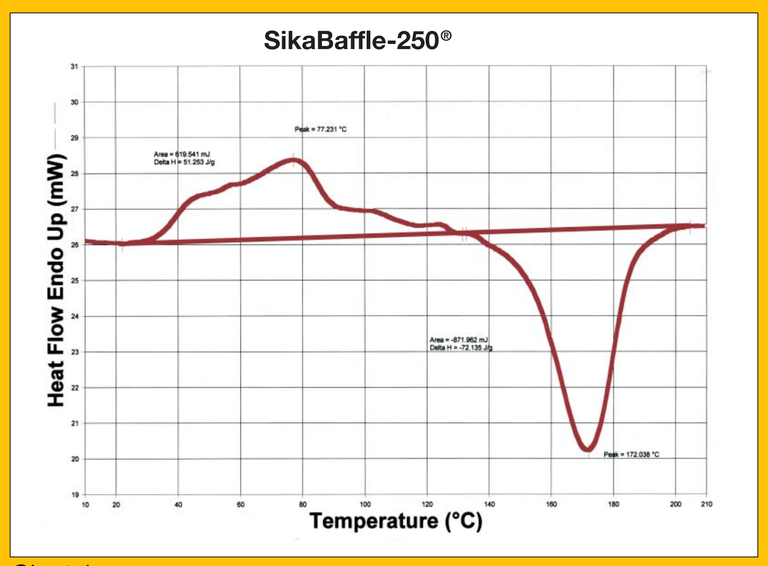

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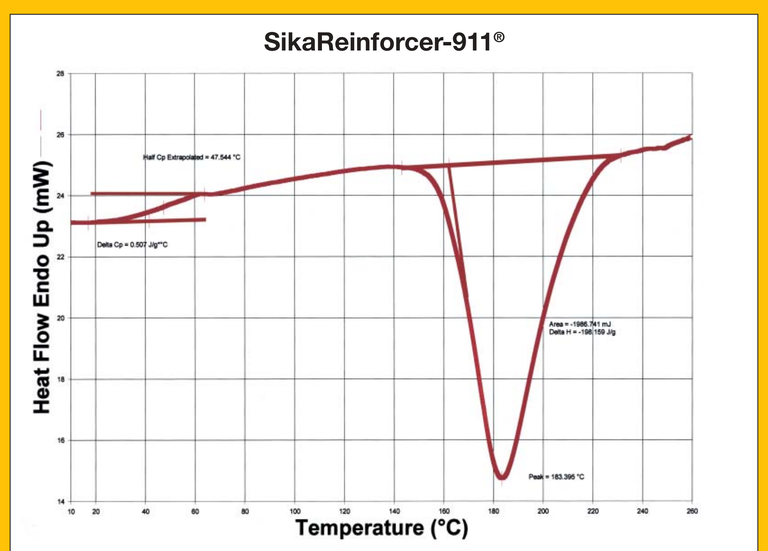

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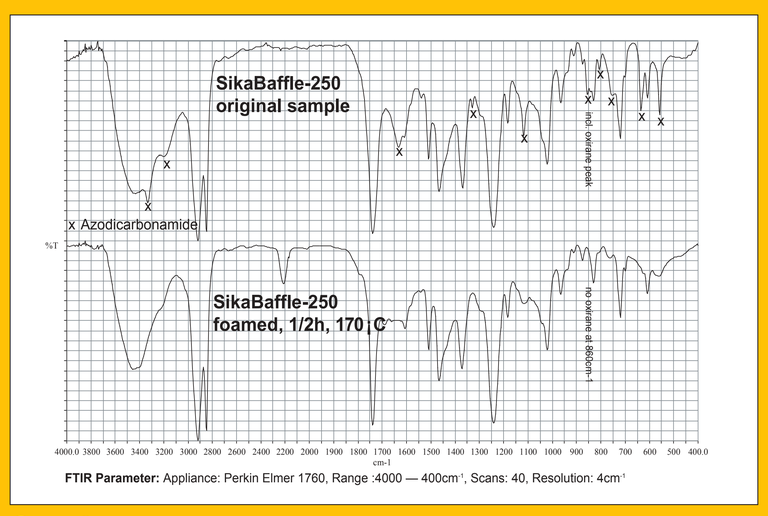

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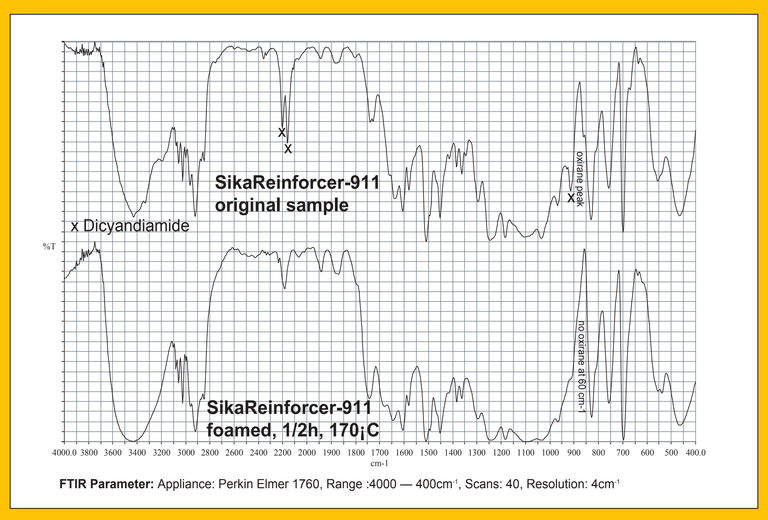

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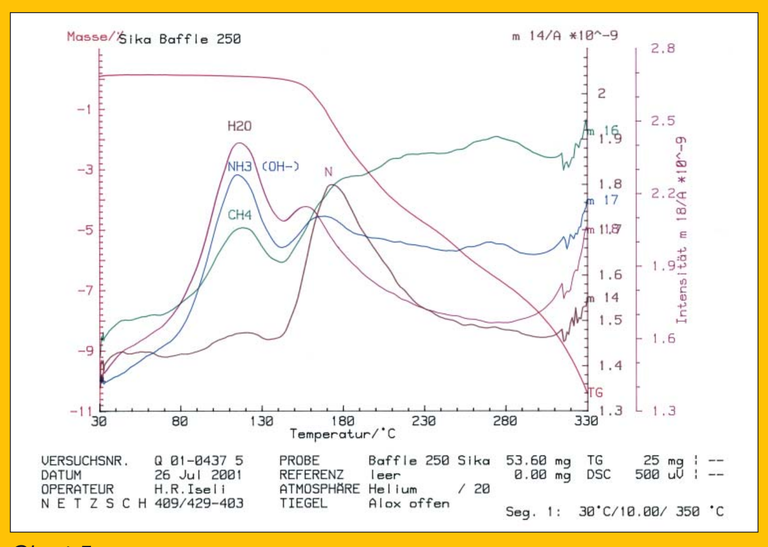

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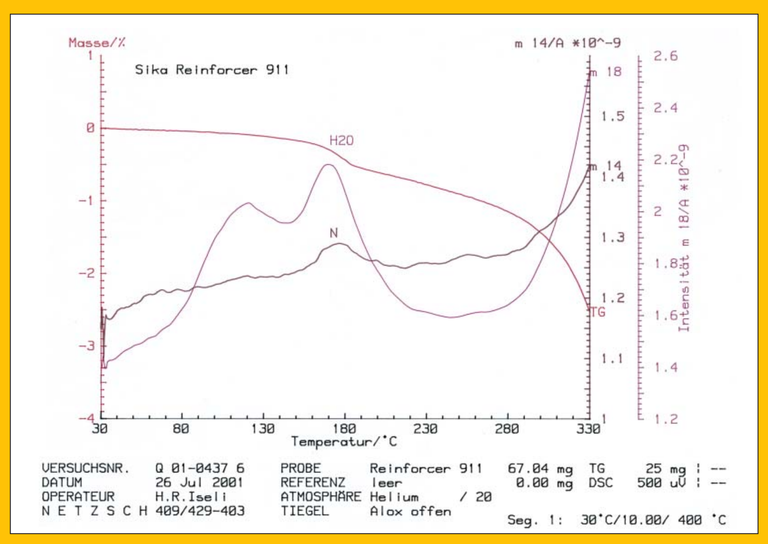

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