Modelling of DMA loss factor of elastomer binders for composite materials to separate binder fractions with different molecular mobility to assess their changes on external impacts

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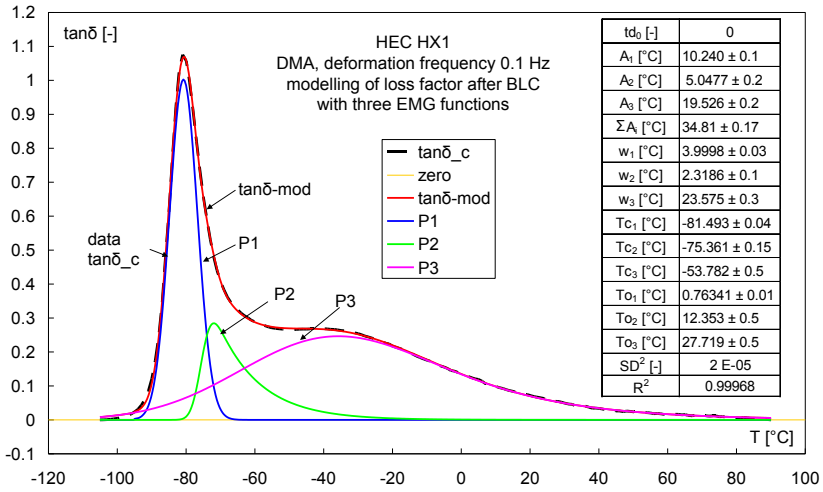
The glass-to-rubber transition temperature of elastomer bonded composite materials is an important property determining their in-service application. As glass-to-rubber transition temperature the main maxima of the loss factor tanδ =G''/G' = E''/E' of the elastomer part is taken here, whereby the loss factor as function of temperature is determined by DMA (dynamical mechanical analysis) measurements at some forced sinusoidal deformation at lower frequencies in the range of 0.01 to 100 Hz. In the temperature range of the loss factor peaks the transition from the energy elastic to the entropy elastic behaviour, or vice versa, occurs. The loss factor of an elastomer binder is influenced by (1) filler type and content, (2) plasticizer type and content, (3) sterical hindrance, (4) interaction forces between all ingredients, (5) polymer chain conformation of the elastomer (6) curing type and agent. The loss factor region of most elastomers filled with rigid particles consists of several sub-transitions, which can change differently during ageing or by applying a change in deformation rate. To quantify these changes a special modelling of the loss factor curve is presented using so-named exponentially modified Gauss distributions. Therewith a separation of the molecular rearrangement regions or binder elastomer mobility fractions is achieved after application of a suitable baseline correction (BLC) to the loss factor curve [1]. The modelling procedure is explained and examples are presented and discussed, see Fig. 1. The differences of the changes in the loss factor parts on external impacts as ageing and deformation rate is an important and useful application of the method.



td_0 [-]	0
A_1 [°C]	10.240 ± 0.1
A_2 [°C]	5.0477 ± 0.2
A_3 [°C]	19.526 ± 0.2
ΣA_i [°C]	34.81 ± 0.17
w_1 [°C]	3.9998 ± 0.03
w_2 [°C]	2.3186 ± 0.1
w_3 [°C]	23.575 ± 0.3
Tc_1 [°C]	-81.493 ± 0.04
Tc_2 [°C]	-75.361 ± 0.15
Tc_3 [°C]	-53.782 ± 0.5
To_1 [°C]	0.76341 ± 0.01
To_2 [°C]	12.353 ± 0.5
To_3 [°C]	27.719 ± 0.5
SD^2 [-]	2 E-05
R^2	0.99968

Fig. 1: Modelling of loss factor tanδ with three EMG functions and separation in three fractions with different molecular mobility. The description is very good with high correlation coefficient.

Keywords:
dynamic mechanical analysis; loss factor; chain mobility; interaction between filler and polymer matrix; modelling of loss factor curve; exponentially modified Gauss distribution; extraction of mobility ranges, separation of elastomer binder fractions with different mobility.

[1] M.A. Bohn, G. Mußbach, S. Cerri. *Influences on the loss factor of elastomer binders and its modelling.* Paper 60, Proc. 43rd International Annual Conference of ICT, June 26 to 29, **2012**, Karlsruhe, Germany. ISSN 0722-4087.