Academic Journal of Polymer Science
ISSN: 2641-8282

Juniper Publishers
key to the Researchers

Short Communication
Volume 5 Issue 1 - April 2021
DOI: 10.19080/AJOP.2021.05.555652

Academ J Polym Sci

Influence of the Moisture Content of Thermoplastics on their Vibroacoustic Behavior

Tom Georgi[1]*, Jan Troge[2] and Jan Diemert[3]*

[1,2]Fraunhofer Institute for Machine Tools and Forming Technology IWU, Germany

[3]Fraunhofer Institute for Chemical Technology ICT, Germany

Submission: April 20, 2021; **Published:** April 27, 2021

***Corresponding author:** Tom Georgi, Fraunhofer Institute for Machine Tools and Forming Technology IWU, Germany

Abstract

The vibroacoustic behavior of plastic components can vary significantly depending on climatic boundary conditions. For example, an electrical device with a plastic housing can sound very different in summer than in winter. Acoustic evaluations of plastic components are therefore mostly carried out under defined climatic boundary conditions. In addition to temperature, the moisture content is often an important vibroacoustic influencing parameter. This contribution deals with the influence of the moisture content of different thermoplastics on their vibroacoustic behavior with regard to vibration damping.

Keywords: Damping; Vibration; Moisture; Acoustics

Introduction

Several plastics can reversibly absorb moisture from the environment, which usually affects their mechanical properties. The vibroacoustic behavior is also often influenced due to changes in mass, rigidity or damping properties. Especially damping is relevant for peak resonance amplitudes of vibrating components. In the following, experimental investigations on the influence of the moisture content of thermoplastics on their damping properties are presented.

Material and Methods

Examinations were carried out using standard tensile samples [1] produced by injection molding. The samples consist of four materials: Acrylonitrile butadiene styrene (ABS), Polycaprolactam (PA6), PA6 GF30 (PA6 reinforced with 30 wt% glass fiber) and a commercial ABS/PA6 blend with higher mass fraction of PA6 than in PA6 GF30. The samples were conditioned at 80 °C with relative humidities of 35 %, 55 % and 75% until mass equilibrium following [2]. For each conditioning step, the measurements were subsequently realized at room temperature. The moisture content of one sample of each material was determined by thermogravimetric analysis. Thereby, the sample is dried (here at a temp. of 80 °C) and the weight loss is measured. In addition to moisture, the weight loss can contain other volatile components. Due to the high air humidity compared to standard climate conditions, this effect is assumed to be negligible. Figure 1 shows the moisture content of the plastics at the different relative humidities. It can be seen that ABS absorbed the least and PA6 the most moisture. With addition of glass fibers to PA6 or PA6 to ABS, the moisture absorption of the base materials decreases or increases, respectively. The damping values were measured by experimental modal analyzes [3]. The setup is shown in Figure 2. The sample (1) was glued to a rigid mass (2) at one end. Then it was excited to vibrate using a modal hammer with integrated force sensor(3). The resulting velocity was measured at the free end (4) using a laser vibrometer. The frequency response function between velocity and force shows resonance peaks at natural bending frequencies. The half width of a peak 3 dB below the maximum is a measure of damping at the natural frequency (modal damping).

Results

Three samples were measured from each material. In Figures 3-6, the frequency dependent modal damping values are shown as a function of relative humidity (RH) with representation of mean values and two-sigma intervals, according to the empirical standard deviation. Modal damping is given in percent, i. e. related to the natural frequency at which it was determined. In the case of ABS, the modal damping is independent of the air humidity. For all other plastics containing PA6, the modal damping depends on it. The higher the air humidity, the greater the modal damping. The effect is most pronounced in the case of pure PA6 and correlates with the measured moisture content in Figure 1. With addition of glass fibers to PA6 or PA6 to ABS, the modal damping of the base materials decreases or increases, respectively. Beyond to the modal damping values, their gradients are influenced by the air humidity for the plastics containing PA6.

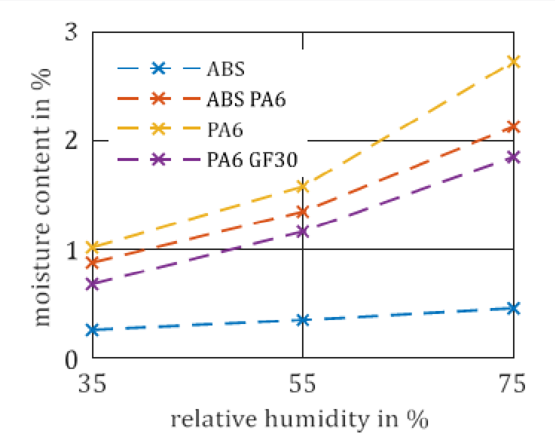

Figure 1: Moisture content of the examined plastics.

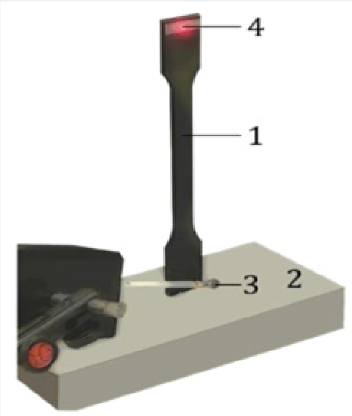

Figure 2: Experimental setup. 1: sample, 2: rigid mass, 3: modal hammer, 4: measurement point.

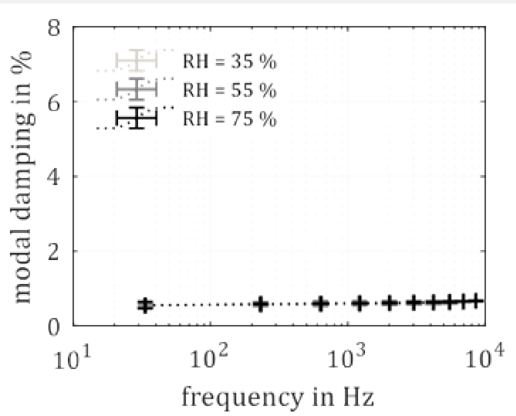

Figure 3: Modal damping of ABS.

How to cite this article: Tom G, Jan T, Jan D. Influence of the Moisture Content of Thermoplastics on their Vibroacoustic Behavior. Academ J Polym Sci. 2021; 5(1): 555652. DOI:10.19080/AJOP.2021.05.555652

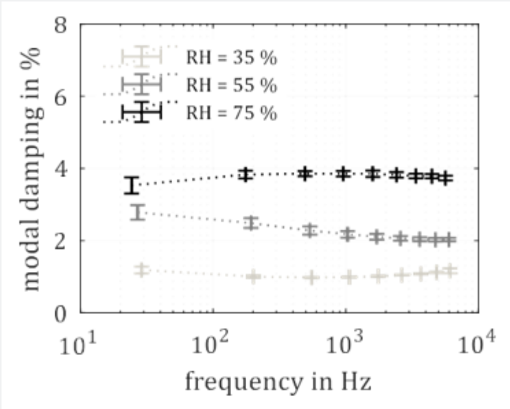

Figure 4: Modal damping of ABSPA6.

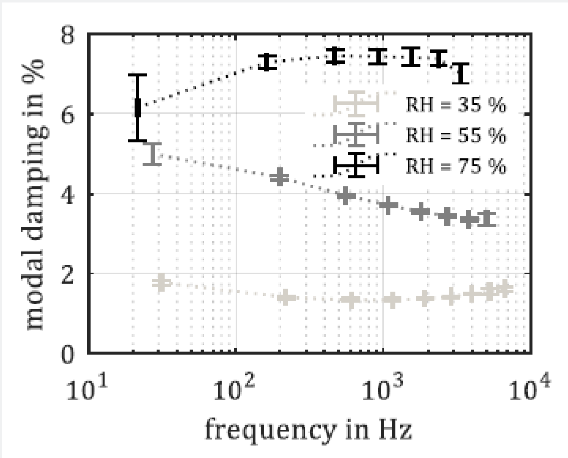

Figure 5: Modal damping of PA6.

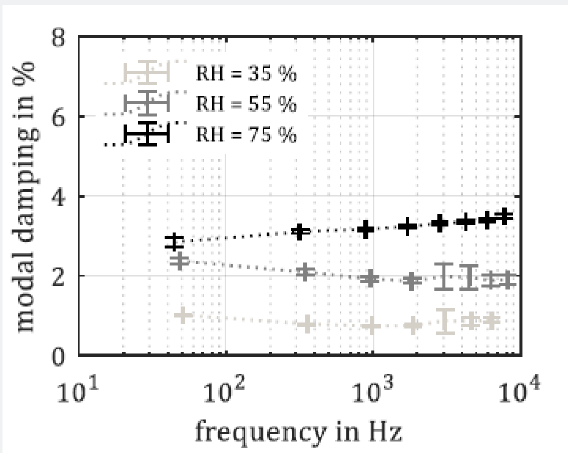

Figure 6: Modal damping of PA6 GF30.

How to cite this article: Tom G, Jan T, Jan D. Influence of the Moisture Content of Thermoplastics on their Vibroacoustic Behavior. Academ J Polym Sci. 2021; 5(1): 555652. DOI:10.19080/AJOP.2021.05.555652

Conclusion

The paper deals with the dependency of damping of different thermoplastics on their moisture content. For determining the damping, experimental modal analyzes were carried out on standard tensile samples. The moisture contents of the samples were varied in three conditioning steps and measured by means of thermogravimetric analyzes. The results show a positive dependency of damping on moisture content, or on relative humidity, respectively, for samples that contain PA6. For the construction of plastic components, moisture absorption is often a challenge. For acoustic perception, this can be rated positively because with higher damping, smaller peaks are to be expected in the case of resonance.

Acknowledgement

i. This work was supported by the Fraunhofer Internal Programs under Grant No. MAVO 836 974.

References

1. Plastics - Multipurpose test specimens (ISO 3167:2014)
2. Plastics - Polyamides - Accelerated conditioning of test specimens (ISO 1110:2019)
3. Ewins DJ (2000) Modal Testing: Theory, Practice and Application (2nd ed.), Research Studies Press.

How to cite this article: Tom G, Jan T, Jan D. Influence of the Moisture Content of Thermoplastics on their Vibroacoustic Behavior. Academ J Polym Sci. 2021; 5(1): 555652. DOI:10.19080/AJOP.2021.05.555652