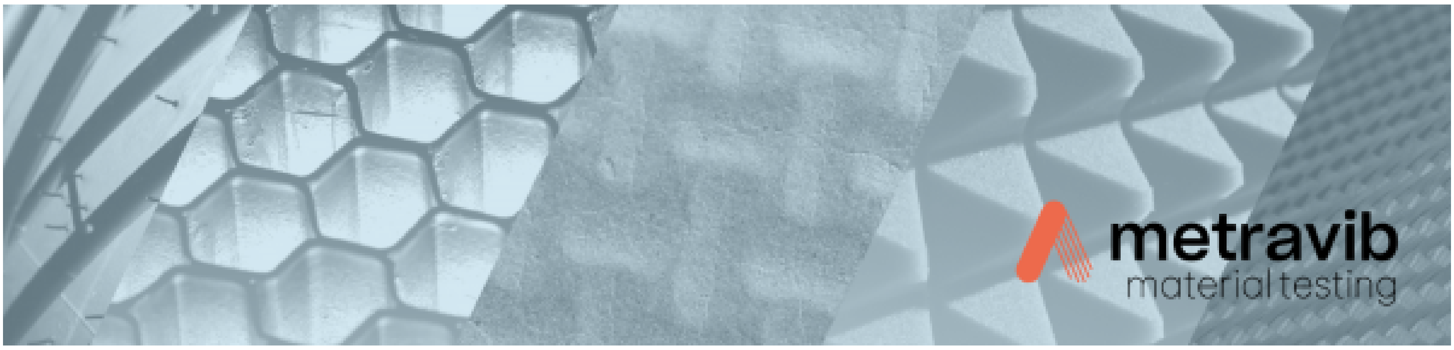


Material's Mechanical Characterization at High Frequency

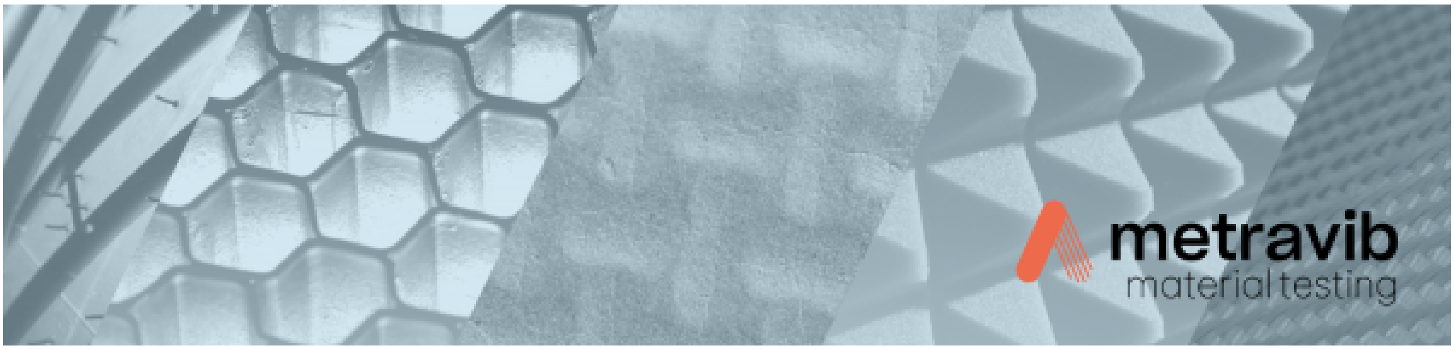
Keywords: DMA, Frequency Sweep, Viscoelastic Materials, Tension, Higher Frequency

Figure 1. Metravib DMA+1000

Introduction

Frequency sweep tests with a DMA are the most commonly used tests to analyze the viscoelastic behavior of polymeric materials. This characterization technique allows us appling a selection of frequencies to a specimen. The main method is to hold the temperature constant and scan across the desired range of frequency with controlling precisely the amplitude of excitation for each frequency.

Most DMA instruments available on the market are limited to a low frequency range of analysis. Featuring characteristics up to 100Hz or 200Hz in the commercial data sheets, the mechanical structure of those instruments frequently limits the frequency analysis to a maximum of a few 10Hz until encountering resonance frequencies affecting the data and preventing any satisfying data exploitation. The Metravib DMA+ series has been designed with a specific care in the mechanical frame structure so that test could be performed accurately up to 200 Hz



and 1000 Hz (option). This document is focused on such high frequency domains.

Materials & methods

The material used for the presented tests was a PUR Elastomer. This is a pourable, elastic, two-component synthetic resin used in construction applications. It is known for its suitability for complex structures. The dimensions (h x b x t mm) of the small rectangular specimen used were 5.1 x 2.25 x 28 mm, respectively. The specimen was studied in tension mode (Figure 2).

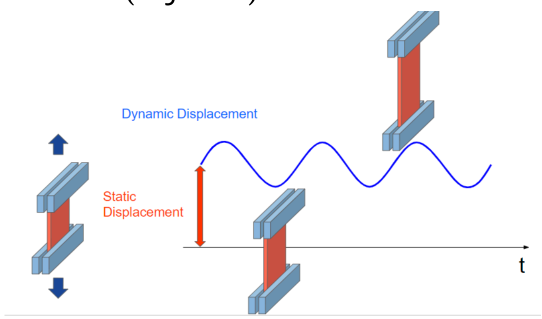


Figure 2. Schematic diagram of tension test mode

Dynamic Strain (%)	0.001
Static Strain (%)	0.002
Frequency (Hz)	0.01 - 1000
Temperature (˚C)	Ambient
DMA	DMA+1000
Test Mode	Tension

Table 1. Test parameters

The Dynamic strain of 0.001% was applied to the specimen from 0.01 to 1000 Hz at ambient temperature. The parameters used for this measurement are mentioned in Table 1.

Results

Figure 3 shows the results obtained for the frequency sweep at room temperature to see the frequency effect at higher frequencies.

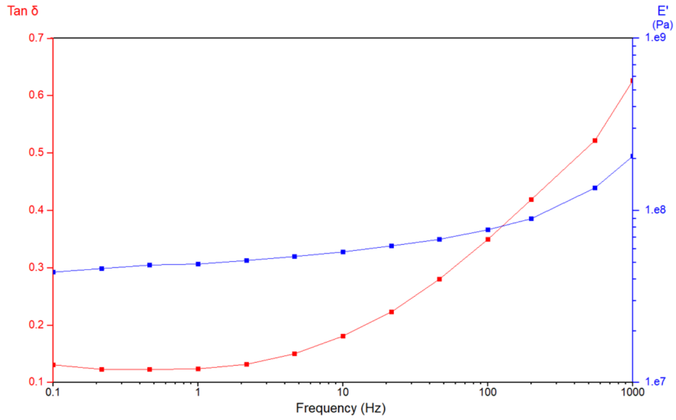


Figure 3. E' and tan δ as a function of frequency.

The results are presented in terms of storage modulus (E') and loss factor (tan δ) as a function of frequency. It can be observed from Figure 3, that with increasing frequency, tan δ and E' increases too, indicating the fact that polymer chains have less time to respond and relax. Henceforth, the material behaves more viscous, leading to the high magnitude of tan δ [1].

Characterization at higher frequency has been useful to understand the behavior of many different polymers during their use, such as the grip ability of the running shoes. This high frequency characterization has been of interest for FEM analysis too.

Conclusions

This study shows the interesting abilities of Metravib's DMA+ series whose test frame stiffness have been specifically designed to reach very high frequencies without the need to extrapolate properties such as master curves This METRAVIB advantage gives direct access to high-frequency mechanical properties, and saves measurement time.

This study, in particular, highlighted the fact that the polymer chains have more time to relax and respond at lower frequencies and hence lower magnitude of tan δ.

References

1. Kevin P. Menard. Dynamic Mechanical Analysis : A practical introduction.

Authors: Pankaj YADAV | pankaj.yadav@acoem.com

More info: www.metravib-materialtesting.com