

High Frequency DMA Data Passing Through the Resonance Frequency of a Sample



Summary

All materials have a resonance frequency. Often this is of little concern as it is above the normal practical mechanical frequencies that the material will be exposed to. It can be important if the material is to be used in an environment where high frequency mechanical stress is applied, such as engine mounts in a car or some aeronautical applications. The resonance frequency is sample dimension/geometry dependent however. Within a DMA, high frequency data is often required and this application note will demonstrate the high (up to 600 Hz) frequency capabilities of the PerkinElmer® DMA 8000 and its ability to continue to collect data through the resonant frequency of the sample. Being able to continue measurement even after a resonant frequency has been reached is important in order to collect the higher frequency data.

Introduction

DMA works by applying an oscillating force to the material and the resultant displacement of the sample is measured. From this, the stiffness can be determined and the modulus and $\tan \delta$ can be calculated. $\tan \delta$ is the ratio of the loss modulus to the storage modulus. By measuring the phase lag in the displacement compared to the applied force it is possible to determine the damping properties of the material. $\tan \delta$ is plotted against temperature and the glass transition is normally observed as a peak since the material will absorb energy as it passes through the glass transition.

The DMA 8000 can go up to 600 Hz frequency in all geometry modes. This ability makes the instrument ideal to examine resonance effects in materials as these invariably occur at the higher frequency ranges. In addition, when a resonance occurs, the instrument does not end the

experiment. The data collected at resonance is often meaningless but the data collected after resonance can be vital. In one experiment, it will be demonstrated how the instrument can perform an isothermal frequency sweep of a sample and collect data before and after the resonant frequency.

Experimental

Frequency sweep of stainless steel.

The sample was loaded into the Single Cantilever Bending clamps and the temperature allowed to equilibrate. Data was collected at discrete frequencies over approximately 1 minute.

Equipment	Experimental Conditions	
DMA 8000	Sample:	Stainless Steel Shim
	Geometry:	Single Cantilever Bending
	Dimensions:	7.3 (l) x 12.5 (w) x 0.25 (t) mm
	Temperature:	24.4 °C
	Frequency:	1.0 to 300 Hz (30 discrete frequencies)

Results and conclusion

Figure 1 shows the modulus and $\tan \delta$ data for stainless steel as a function of frequency. As expected, both values are relatively constant over the frequency range. The values at 250 Hz are the exception to this and should not be interpreted. They merely reflect the material undergoing resonance. During resonance, the instrument can not collect sensible data as the strain measured by the instrument will be completely out of phase with the stress and will not reflect the mechanical properties of the material. Stainless steel was chosen as an example of this technique as it has a relatively high resonance. This technique can equally be applied to other metals or polymeric materials with ease. The ability of the instrument to cope with high frequencies, even in a bending geometry, is demonstrated. Also, the ability to continue measurement through the resonant frequency is shown. This is a unique advantage if higher frequency data is important.

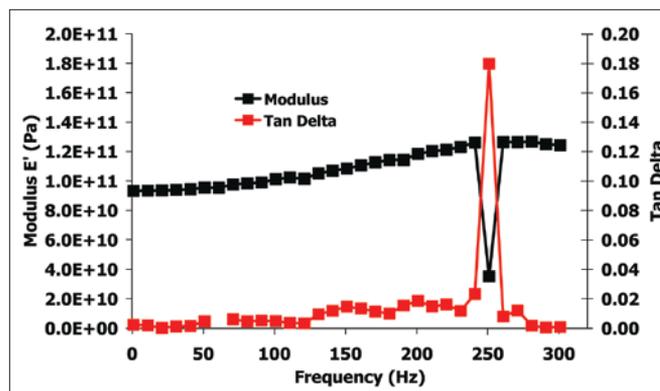
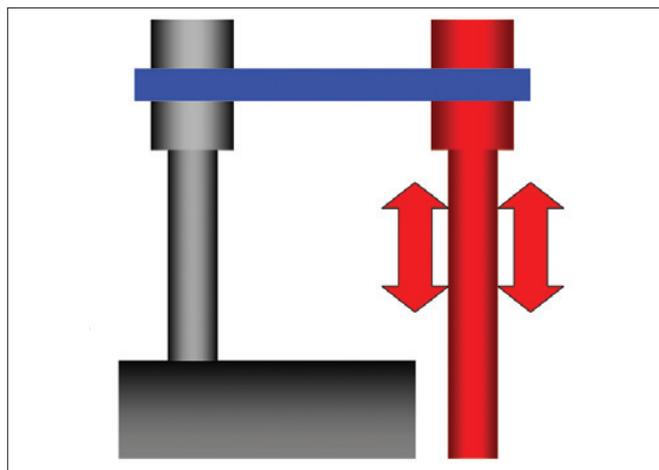


Figure 1. Modulus and $\tan \delta$ for stainless steel.