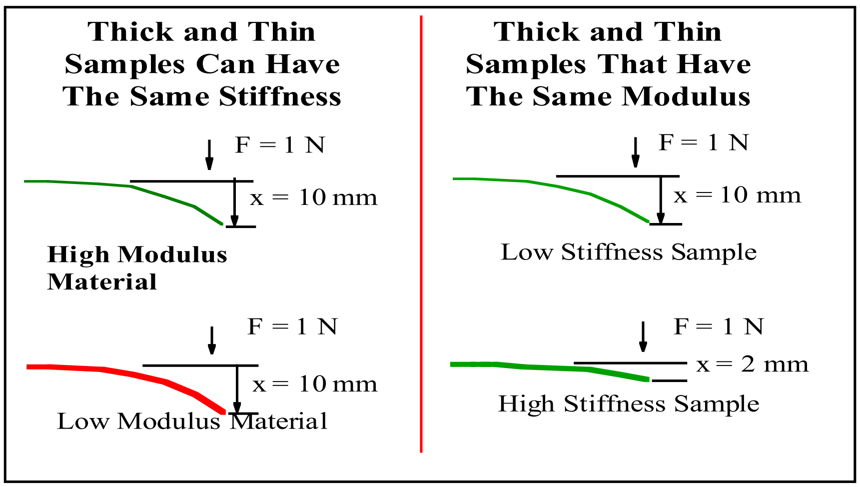
TA Instruments

Thermal Analysis & Rheology

THERMAL SOLUTIONS

Determining the Optimum Sample Size for Testing a Film in the DMA 2980



When designing an experiment on a dynamic mechanical analyzer, many factors such as ramp rate, frequency, and deformation amplitude must be considered. Perhaps one of the most overlooked considerations when designing an experiment is the sample geometry, i.e. sample length, width, and thickness. Many times it is assumed that as long as the sample fits into the clamp of interest, accurate measurements can be made. For example, the Tension Film clamp of the DMA 2980 can accommodate samples up to 2 mm thick, however this does not necessarily mean that all samples of this thickness can be tested. To understand why the sample size is such an important consideration we must discuss the difference between sample modulus and sample stiffness.

The modulus of a material is an intrinsic property; it is independent of the size of the sample. The stiffness of a sample is an extrinsic property; it is completely dependent on the dimensions of the sample. For example, consider a bar of aluminum one foot long and two inches thick. If you were to try to bend the bar of aluminum with your hands, it would be difficult. Now consider a sheet of aluminum foil. It is obviously very easy to bend and deform the sheet of foil. Both the aluminum foil and aluminum bar have the same modulus, but the stiffness of the two samples is very different. Put another way, two materials of different modulus can have the same stiffness if the dimensions of the two samples are different. This concept is shown schematically in the figure above.

The geometry factor, GF, equation below can help you determine the optimum sample size for the film material under test, or determine if a film of a particular size can be measured.

GF = L/A where L is the length and A is the cross sectional Area

The sample modulus is calculated in the DMA 2980 by multiplying the measured sample stiffness, Ks, by the geometry factor, GF.

Modulus = Ks x GF or Modulus = Ks x (L/A)

where the measurable stiffness range of the instrument is a fixed quantity between 100 to 10,000,000 N/m. It can be seen from this equation that the measurable modulus range for a given sample size can be determined by solving the equation at the minimum and maximum stiffness values. Note we can solve the modulus equation above for stiffness as follows

Ks = Modulus/GF or Ks = (Modulus x A)/L

Since the modulus of the material is an intrinsic property, i.e. independent of the sample dimensions, it can be seen that the sample dimensions must be selected to yield stiffness values within the allowable measurable range of the instrument.