

STORAGE MODULUS CHART



What is a storage modulus? The storage modulus is a measure of how much energy must be put into the sample in order to distort it. The difference between the loading and unloading curves is called the loss modulus, E'' . It measures energy lost during that cycling strain. Why would energy be lost in this experiment? In a polymer, it has to do chiefly with chain flow.



What is the difference between loss modulus and storage modulus? The storage modulus G' (G prime, in Pa) represents the elastic portion of the viscoelastic behavior, which quasi describes the solid-state behavior of the sample. The loss modulus G'' (G double prime, in Pa) characterizes the viscous portion of the viscoelastic behavior, which can be seen as the liquid-state behavior of the sample.



What is the difference between storage and loss moduli in dynamic mechanical analysis? Measuring both storage and loss moduli during dynamic mechanical analysis offers a comprehensive view of a material's viscoelastic properties. The storage modulus reveals how much energy is stored elastically, while the loss modulus shows how much energy is dissipated as heat.



What does a high and low storage modulus mean? A high storage modulus indicates that a material behaves more like an elastic solid, while a low storage modulus suggests more liquid-like behavior. The ratio of storage modulus to loss modulus can provide insight into the damping characteristics of a material.



What is elastic storage modulus? Elastic storage modulus (E_a) is the ratio of the elastic stress to strain, which indicates the ability of a material to store energy elastically. You might find these chapters and articles relevant to this topic. Georgia Kimbell, Mohammad A. Azad, in *Bioinspired and Biomimetic Materials for Drug Delivery*, 2021

STORAGE MODULUS CHART



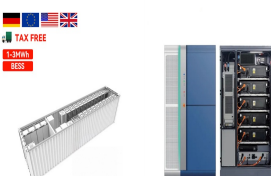
What is storage modulus in tensile testing? Some energy was therefore lost. The slope of the loading curve, analogous to Young's modulus in a tensile testing experiment, is called the storage modulus, E' . The storage modulus is a measure of how much energy must be put into the sample in order to distort it.



The elastic modulus for tensile stress is called Young's modulus; that for the bulk stress is called the bulk modulus; and that for shear stress is called the shear modulus. Note that the relation between stress and strain is an observed relation, measured in the laboratory. Elastic moduli for various materials are measured under various



Up-to-date predictive rubber friction models require viscoelastic modulus information; thus, the accurate representation of storage and loss modulus components is fundamental. This study presents two separate empirical formulations for the complex moduli of viscoelastic materials such as rubber. The majority of complex modulus models found in the a?]



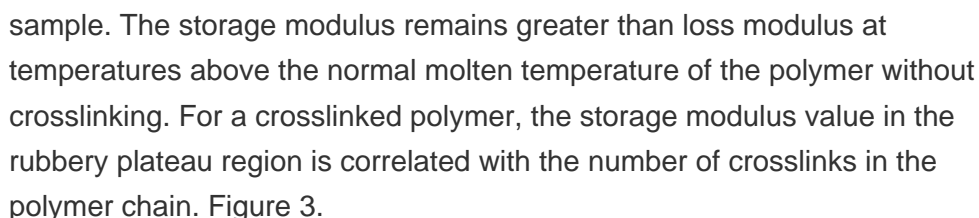
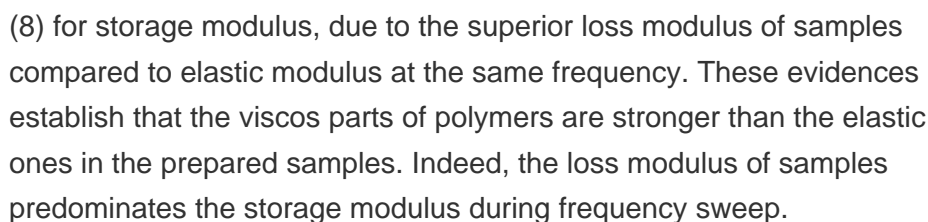
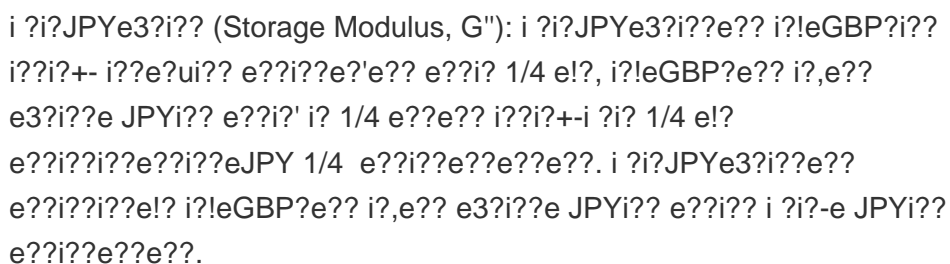
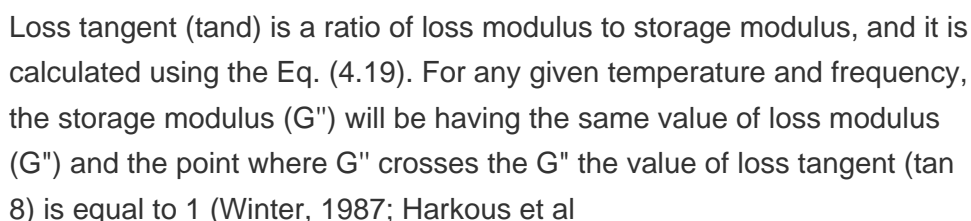
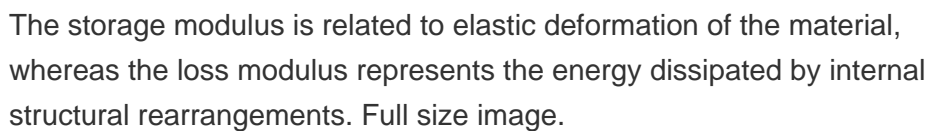
Complex modulus (M^*): modulus of elasticity, Young's modulus (E^*) or shear modulus (G^*) Storage modulus, M_a , proportional to the energy stored elastically and reversibly; Loss modulus, M'' , proportional to the energy transformed into heat and irreversibly lost; Loss factor, $\tan \delta$. With completely elastic materials no phase shift, δ

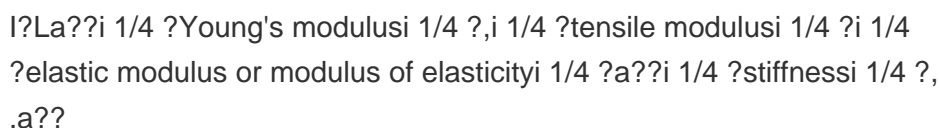
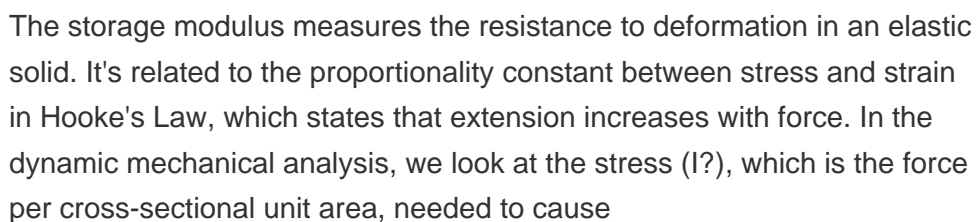
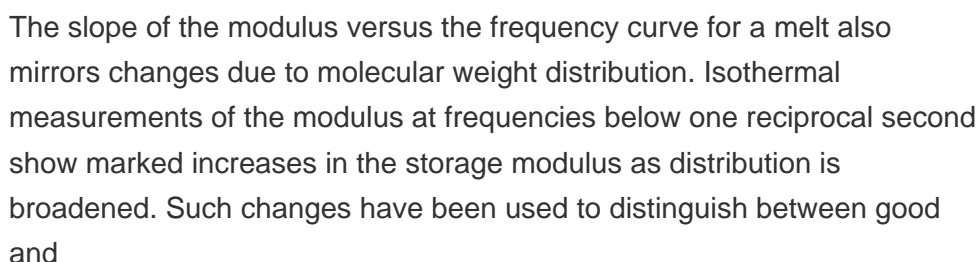
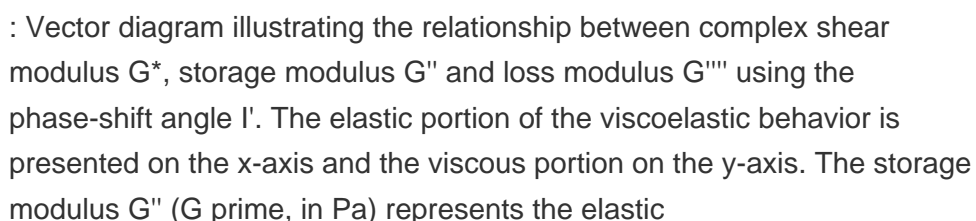
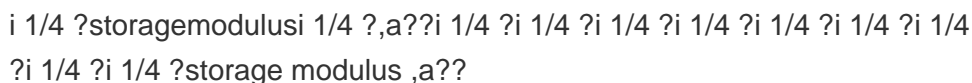


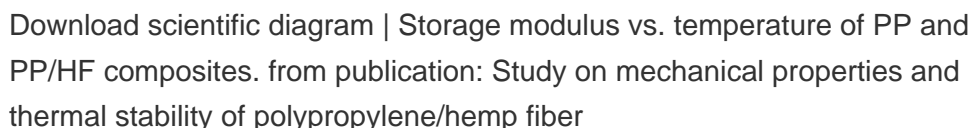
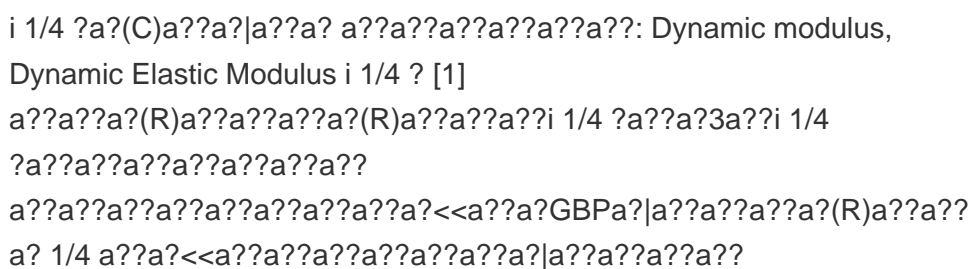
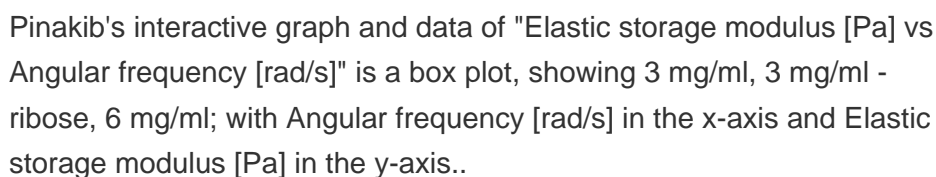
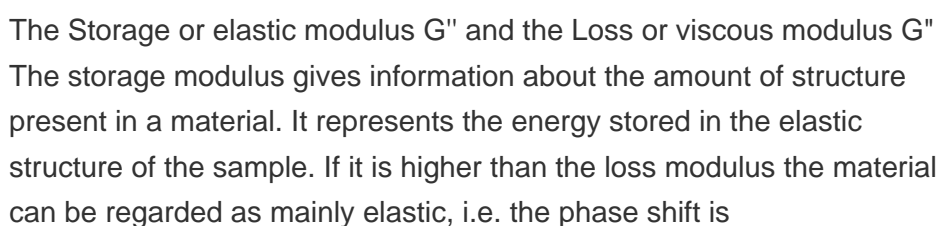
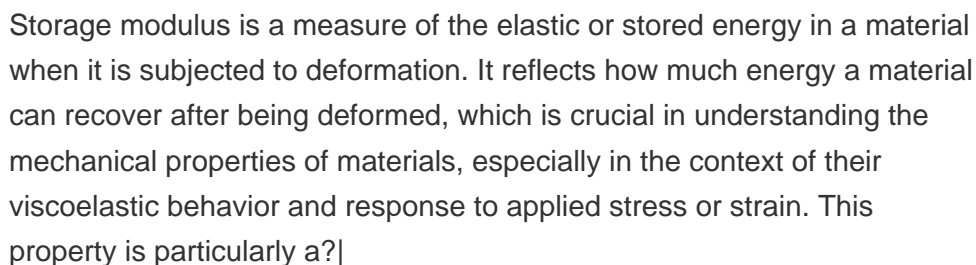
δ and the modulus-at-application temperature are two key parameters characterizing the performance of a PSA. An adhesive performing over a wide temperature range (e.g. deep freeze label) needs a low $\tan \delta$ peak and a constant storage modulus value around 105 Pa over a range of use temperatures. If the modulus becomes higher than



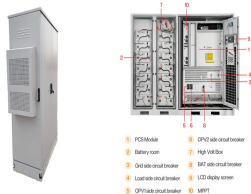
ASTM/ISO/JIS DMA (Dynamic Mechanical Analyzer), (Storage Modulus), (Loss Modulus), (Tan delta) (δ) (T_g , Glass transition temperature)







STORAGE MODULUS CHART



5. (Compression Modulus) . 6. (Storage Modulus) E'' , $a??a??E''$, $a?$



Young's modulus, or storage modulus, is a mechanical property that measures the stiffness of a solid material. It defines the relationship between Stress Stress is defined as a level of force applied on a sample with a well-defined cross section. (Stress = force/area). Samples having a circular or rectangular cross section can be compressed



1/frequency, or 1 second for the results in Figure 1. The storage modulus will drop at higher temperatures for faster deformations and slower deformations would experience a drop in the storage modulus at cooler temperatures. GLASS TRANSITION FROM THE LOSS MODULUS AND $TAN(\delta)$ The T_g measured from the loss modulus and $\tan(\delta)$ signals require



the loss modulus, see Figure 2. The storage modulus, either E'' or G'' , is the measure of the sample's elastic behavior. The ratio of the loss to the storage is the tan delta and is often called damping. It is a measure of the energy dissipation of a material. Q How does the storage modulus in a DMA run compare to Young's modulus?



the stiffness of the material. Figure 4 shows a chart of measured IRHD versus Young's Modulus. Note that the chart uses a semi-log scale (IRHD is on a linear scale plotted against the logarithm of Young's Modulus). 0 10 20 30 40 50 60 70 80 90 100 11.5 22.5 33.5 4 Log 10 E Figure 4: IRHD vs. Log E'' False Sense of Security

STORAGE MODULUS CHART



When using the storage modulus, the temperature at which E'' begins to decline is used as the T_g . $\tan \delta$ and loss modulus E'' show peaks at the glass transition; either onset or peak values can be used in determining a_T .



Dynamic mechanical analysis (abbreviated DMA) is a technique used to study and characterize materials is most useful for studying the viscoelastic behavior of polymers. A sinusoidal stress is applied and the strain in the material is measured, allowing one to determine the complex modulus. The temperature of the sample or the frequency of the stress are often varied, a_T .



So for a typical polymer with a storage Young's modulus E_a of 3 GPa, this selection chart suggests an extreme range for the loss modulus E_a between 0.03 and 0.3 GPa. Figure 7