

# Storage modulus of hydrogel

What is the storage modulus of a hydrogel?

The storage modulus of hydrogel increases with increasing polymer concentration. The hydrogel showed storage moduli of 200 and 400 Pa at 1.5% and 2% (w/v), respectively. Under these conditions, the loss modulus only increases from 12 to 18 Pa when increasing concentration.

What is the rheological behavior of a forming hydrogel?

The rheological behavior of the forming hydrogel is monitored as a function of time, following the shear storage modulus  $G'$  and the loss modulus  $G''$  (Fig. 1). The storage modulus  $G'$  characterizes the elastic and the loss modulus  $G''$  the viscous part of the viscoelastic behavior.

Do hydrogels display a constant storage and loss modulus?

Hydrogels displayed a constant storage and loss modulus in the tested strain range. Frequency sweep, in the 0.01-10 Hz interval at 0.1% constant strain, was then performed on the hydrogel samples. Seven experimental points were acquired per each frequency decade. Tests were performed at 37 °C in wet conditions.

How to determine the viscoelastic properties of hydrogels prepared under different conditions?

The frequency and amplitude of the vibration were adjusted to 100 Hz and 50 mm, respectively. From the dynamic mechanical analysis, we determined the storage modulus ( $G'$ ), loss modulus ( $G''$ ) and loss factor ( $\tan \delta = G''/G'$ ) to evaluate the viscoelastic properties of the hydrogels prepared under various conditions.

What is the elastic modulus of hydrogels?

The elastic modulus of this formulation of hydrogels has values of 0.1-1.0 MPa, two to three orders of magnitude higher than previously reported for the natural polymer counterpart, with a water content of up to 90wt% (Gong, 2010; Kawauchi et al., 2009; Tanaka et al., 2005).

How do hydrogels affect mechanical properties?

We initially use a basic hydrogel model to clarify the influences of the molecular structure and swelling or deswelling on the mechanical properties, encompassing the elastic modulus, extensibility, strength, toughness and fatigue resistance.

The Storage or elastic modulus  $G'$  and the Loss or viscous modulus  $G''$  The storage modulus gives information about the amount of structure present in a material. It represents the energy stored in the elastic structure of the sample. If it is higher than the loss modulus the material can be regarded as mainly elastic, i.e. the phase shift is ...

This DNA hydrogel yielded a storage modulus ( $G'$ ) ranging from 5-7 Pascals (Pa) at frequencies between 0.1-100 Hertz (Hz). Geng et al. found similar mechanical properties when using the same technique to produce a DNA hydrogel seeded with silver nanoclusters. ... The change in plateau storage modulus as a function of

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molar DNAs ...

The storage modulus  $G'$  from the data and the SGR model match each other well even up to  $\omega / G_0 \sim 1$  where we cannot expect good agreement. This promising behavior also gives us the interpretation that mechanistically the cytoskeleton possesses a linear log-log relaxation-time spectrum and further that for the storage modulus the cytoskeleton is well modeled by the ...

The storage modulus  $G'$  and the loss modulus  $G''$  at a selected frequency were plotted against the cross-linking density for P(NIPAM-BIS) and P(NIPAM-PEGDA) hydrogels (Fig. 5) revealing the relative large value of the storage modulus  $G'$  compared to the loss modulus  $G''$ , which is characteristic for all investigated hydrogels at both ...

As aforementioned, the Young's modulus and shear modulus of a hydrogel can be interconverted with its Poisson's ratio if the gel is isotropic:  $E = 2G(1 + \nu)$ . Based on this principle, it is possible to measure the elastic modulus of hydrogels by measuring their shear modulus using a parallel-plate-type rheometer [20,21,22,23].

Hydrogels have been extensively studied for biomedical applications such as drug delivery, tissue-engineered scaffolds, and biosensors. There is a gap in the literature pertaining to the mechanical properties of hydrogel materials subjected to high-strain dynamic-loading conditions even though empirical data of this type are needed to advance the design ...

Overall, both hydrogels demonstrate shear-thinning abilities and a change in loss and storage modulus at different strain; however, the 5% hydrogel has overall lower viscosity, storage, and loss moduli compared to the 7.5% hydrogel, which leads to a conclusion that it should be more suited and easier to inject .

The storage modulus of the ECM hydrogel is frequently lower than the respective tissue from which the hydrogel is derived. The hydrogel should be thought of, at least in part, as an inductive template to recruit cells that will secrete de novo ECM comprising the stiffness of the new tissue.

The results revealed the viscoelastic response of the hydrogels and storage modulus was higher than loss modulus and hydrogels were highly elastic. This elasticity was owing to the carboxylic acid groups present and the interaction between cations from the salt and carboxylate anion. In addition, mechanical strength of the hydrogel was ...

Hydrogel energy storage technology has entered a high-speed development stage, the breakthrough in the field of electrochemical energy storage is particularly significant, can now replace a variety of structures in the energy storage device, and even derived from the all-hydrogel energy storage device, at the same time, the direction of research of hydrogel ...

The storage modulus was superior over the loss modulus for all the concentration of chitosan/PVA hydrogel

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referring that the hydrogels possess innate structure. The increased storage modulus of all the hydrogels over the loss modulus strongly confirms that the hydrogels are crosslinked.

To assess the effect of cations on the mechanical properties of alginate hydrogels, the storage modulus  $E'$  and loss modulus  $E''$  were measured in small-amplitude oscillatory tests. The effect of frequency  $f$  on the storage  $E'$  and loss  $E''$  moduli of gels prepared with 1 M divalent cations is illustrated in Figure 1 A.

The viscoelastic properties and tensile properties showed that when the mass fraction of borax is 5%, the storage modulus and compressive stress of the hydrogel are the highest, reaching 100 Pa and 5.6 kPa, respectively. ... and loss modulus ( $G''$ ) of Borax-PVA hydrogel in the frequency range of 0.01-100 Hz. When the storage modulus ( $G'$ ) ...

1 Introduction. Almost all components of the human body include hydrogels, which primarily consist of water molecules within polymer networks. Such natural hydrogels (biological tissues) are ionically conductive and adaptable to various morphologies in physiological environments, exhibiting a unique combination of mechanical properties, including variable strength, stiffness ...

enhance the modulus of the hydrogel. Thus, the modulus of the PAM-CS hydrogel can reach 0.3-0.4 MPa through crystal-lization enhancement; however, the use of a strong base may cause potential problems in applications.<sup>14</sup> Therefore, it is a big challenge to produce a hydrogel with high modulus through a convenient, efficient, and green ...

Storage modulus is a measure of the energy stored and recovered from a material per cycle, indicating its solid or elastic character. From: Food Chemistry, 2000. ... The storage modulus and compression strength of the prepared hydrogel were measured by a rheometer (MARS, HAAKE, Germany). A rheological sample was cut into a circular tube with ...

the hydrogel and the resultant deformation of the hydrogel. On a macroscale, Young's modulus is usually obtained by measuring the stress-strain curves of a hydrogel specimen through the compression method or the tensile method and then finding the slope of the curve. Also, the shear modulus of a hydrogel is

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 difference between the loading and unloading curves is called the loss modulus,  $E''$ . It measures energy lost ...

The most distal surfaces of lubricious high water-content aqueous gels may have decreasing concentrations and gradients of macromolecular chains on the surface that emanate outward into the environment. This superficial zone of extended polymer chains has a water-content that approaches 100% over the final few hundred nanometers, and the ...



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Hydrogels are three-dimensional (3D) cross-linked polymer networks, which can absorb and retain large amount of water. Because of their tunable properties as well as their versatile fabrication methods, hydrogel materials have been applied in a wide range of biomedical and engineering applications, ranging from tissue engineering and regenerative medicine to ...

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