Sol-Gel transition temperature

Complex_Fluids_0006-1

Industry overview

The complex fluids industry sector uses a variety of complex fluids to show the types of processing issues and analytical testing requirements that many industries will be familiar with. For more information, see the Industry overview by searching in rFinder for Complex Fluids.

Abstract

Gelation is the process by which a liquid is converted into a solid or soft solid by formation of a network of chemical or physical bonds between the molecules or particles that constitute the liquid. The liquid is called the sol and the resulting solid or soft solid is the gel. Gels can be either chemical gels or physical gels. Chemical gels can result from cross-linked structures, while physical gels can arise from intermolecular association. There are three types of interactions that can lead to physical gels- (1) local helical structures (2) microcrystallites and (3) nodular domains. For more information, see the referenced books at the end of this note.

The network structure of most gels is temperature dependent. Some gels are reversible meaning that sol/gel transitions will reform at a specific temperature. Gelatin is an example of a reversible gel.

In order to measure the gel temperature the sample is heated at a constant rate and the storage modulus G' is measured. Care must be taken to strain the gel structure as little as possible preserve the structure until it reverts to a sol.

Experimental

The rSolution sequence Complex_Fluids_0006-1 Sol-Gel transition temperature measures the elastic modulus G' as the temperature is increased through a temperature table. G' will decrease until the sol point is reached and will then plateau. This sequence measures the Linear visco-elastic region (LVER) of the sample, and then uses an appropriate shear strain to measure the sample through the Sol-Gel transition. The transition temperature is automatically calculated by measuring the minimum of the G' vs temperature curve. The Sol-Gel transition is measured using a single frequency oscillation at 1 Hz, which is used as a standard frequency in many oscillatory measurements.

Results

A complex fluid, jelly, was measured using a vane geometry and the results are shown in figure 1.

The jelly sample investigated underwent a sol-gel transition as evidenced through a lowering and then reaching a plateau of G' on increasing the temperature. The sol-gel transition temperature for this sample was 35°C.

Conclusion

The Jelly sample showed a classic Sol-Gel transition. The G' vs Temperature curve reached a minimum value and then a plateau, as described in the literature.

The sequence drives the user through all the required steps to measure the change in G' arising from a structural change due to a sol-gel transition. The important rheological values such as the extent of the LVER are determined and re-used automatically by the sequence as it progresses.

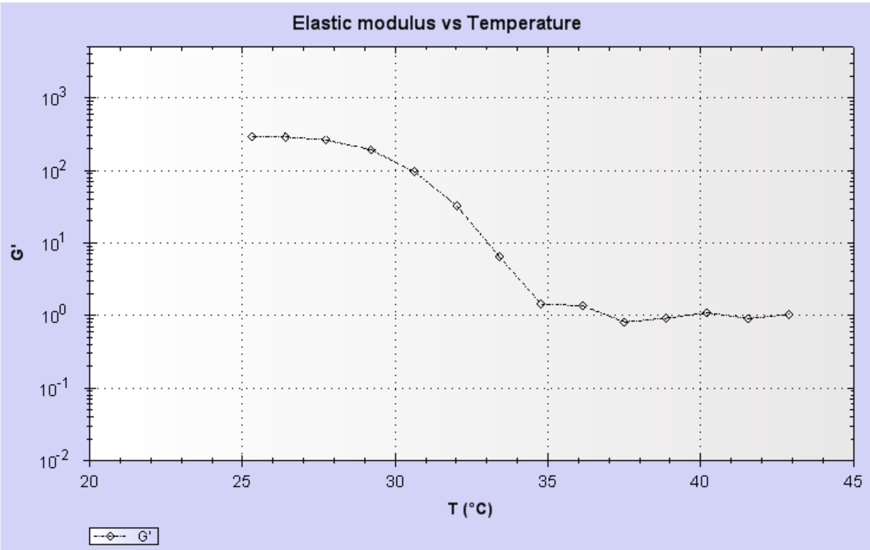

Figure 1: Oscillatory temperature sweep of a jelly to follow the sol-gel transition

Malvern

Accessory options

This sequence is designed to work with a vane geometry, roughened cup and bob, serrated parallel plates or roughened parallel plates. It has been set to work only with these types of geometries. If parallel plates are being used, it is recommended that the diameter used is greater than 35mm.

Roughened or serrated geometries are recommended to overcome slippage, large geometries are recommended because the sample is low viscosity.

Sequence description

This sequence consists of the following:

Sample_0014-1 Standard load sample sequence all geometries - with choice to load or not Drives the user through loading a sample

Oscillation_0001-1 Amplitude sweep shear stress controlled with LVER determination Runs an amplitude sweep & determines LVER and a stress within the LVER to use in the oscillatory time sweep

Oscillation single frequency timed Runs an oscillatory time sweep to determine changes in G' with time as the temperature changes through a temperature gradient.

Sample_0012-1 Unload sample plates and cones Drives the user through unloading the sample

Other related information

Industry overview for Complex Fluids

Other sequences within the Complex Fluids section.

The 'My Sample' section of the help file (rPages/My Sample)

References

An Introduction to Rheology-Barnes, Hutton & Walters.
The Structure & Rheology of Complex Fluids-Ronald G. Larson