



High precision determination of gel point by Time-Cure-Superposition

Application

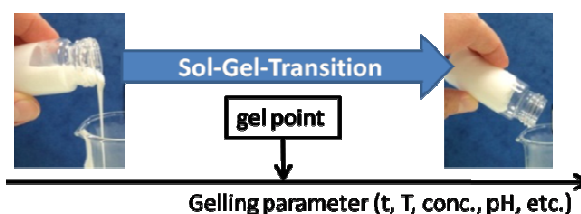
Cosmetics & Pharmaceuticals
Food
Paints & Building materials

Device

RheolaserMaster®

Introduction

Gels have become omnipresent during the last decades due to their unique viscoelastic properties, which can be used to stabilize and texturize in all kind of applications (food, cosmetics, pharmaceuticals, paints, etc.). A gel is usually defined as a dispersion of one phase (water, oil, air) in a 3-dimensional solid continuous phase of fibers or particles bound physically or chemically (Ferry et al., 1980, Wiley). The gel formation is influenced by a whole range of parameters, including type and quantity of the solvent, of the network-forming component or of the gelling agent, as well as temperature, pH, etc. An important parameter of gel analysis is the gel point, i.e. the transition point between the liquid phase and the solid-like jelly-phase.



Several definitions of the gel point are applied in conventional rheology. The Winter-Chambon-Criterion, the most complete definition of the gel point, defines the gel point as the point at which $\tan \delta$, and therefore the relation between G' and G'' , is constant over a wide range of frequencies.

Figure 1 shows the schematic representation of G' , G'' and $\tan \delta$ at the gel point. It has to be noted, that G' is not necessarily equal to G'' at the gel point (Winter et al. 1986, J. Rheology).

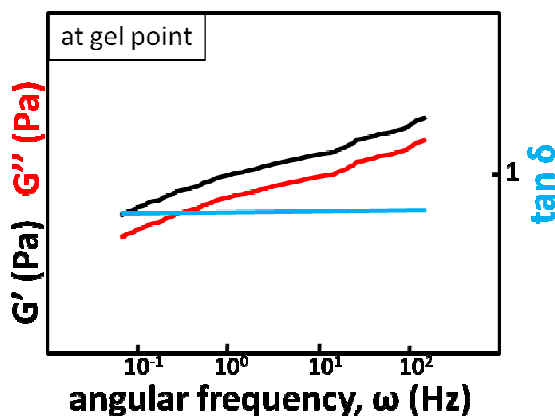


Figure 1 : Schematic representation of G' (black), G'' (red) and $\tan \delta$ (blue) at the gel point.

The Winter-Chambon-Criterion obliges therefore to study the gelation process at different frequencies to determine precisely the gel point. Usually, the $\tan \delta$ measured for different frequencies are plotted as a function of the gelling parameter. This gelling parameter can be time, temperature or other parameters influencing the gelation process (e.g. pH, concentration, etc.). The gel point is defined as the cross-over of all these $\tan \delta$ curves as shown in Figure 2.

It is obvious that the determination of the gel point according to this definition is time-consuming (sample loading/reloading/cleaning/calibration), which requires considerable amounts of sample. In practice, several simplifications are made to lower operator time and sample consumption. Firstly, $\tan \delta$ is studied at only one frequency, which is usually 1Hz. Secondly, only the cross-over of G' and G'' at this frequency is considered to be the gel point, that means that $\tan \delta = G''/G' = 1$.