Measuring the Mechanical Properties of a Hydrogel

BOWEN INSTRUMENTS

Background

Hydrogels are important materials for (i) biomedical research, (ii) food and nutrition science, and (iii) regenerative medicine. Commonly encountered hydrogels in these fields consist of a polysaccharide, such as alginate, carrageenan, or gellan, solvated by and swollen with water. The hydrogels retain their structure via non-covalent bonding, for example cation/anion interactions.

Measuring the mechanical properties of hydrogels can be problematic due to their high water content. Under ambient conditions they can lose significant mass, via evaporation of water into the surrounding atmosphere, in short periods of time. Further, studying the transient properties of hydrogels under aqueous solution, particularly if their mechanical integrity weakens with time, presents a characterisation challenge.

Objective

Measure the mechanical properties of a 5% (w/v) sodium alginate hydrogel, minimising evaporative loss.

Experimental

Using an AR-G2 rheometer (TA Instruments, UK), incorporating a custom-built stage [**Figure 1**]. The stage allows a reservoir of liquid to be retained around the sample, maintaining sample hydration, and a lid is used to minimise evaporative losses. Stress relaxation data were obtained for 5-6 mm thickness slabs of sodium alginate hydrogel, manufactured according to the methodology described by Kaklamani et al. [1]. Samples were housed in the rheometer and constrained under a 2 N compressive normal load, using a sandblasted parallel plate configuration.

Results

The results obtained following an oscillatory motion corresponding to 1% strain are shown in **Figure 2**; the data were fitted to a 6-element Prony series.

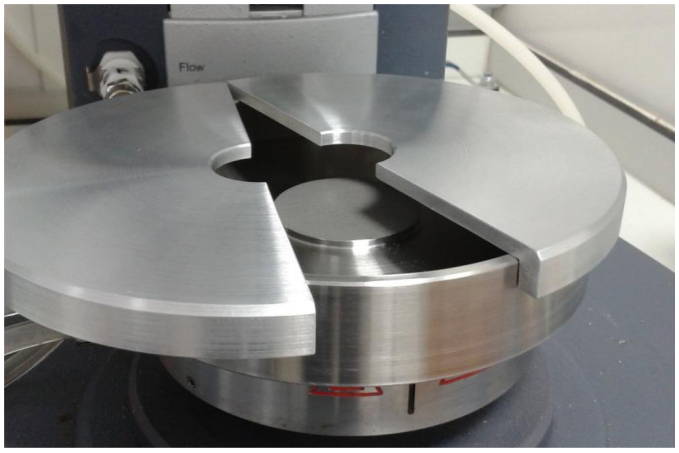

Figure 1. Rheometer enclosure, incorporating walled chamber, sandblasted centre stage, and removable lid

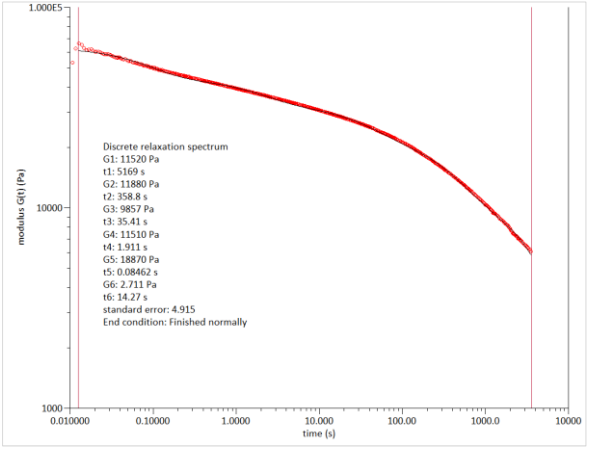

Figure 2. Stress relaxation data and fitted relaxation spectrum for 5% (w/v) sodium alginate hydrogel

References

1. Kaklamani, G.; Cheneler, D.; Grover, L.M.; Adams, M.J.; Bowen, J.; Mechanical properties of alginate hydrogels manufactured using external gelation, *J. Mech. Behav. Biomed. Mater.*, **2014**, *36*, 135-142.

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